THE

ELECTRICAL REVIEW.

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J. A. BERLY'S

UNIVERSAL ELECTRICAL DIRECTORY

For 1893,

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STORAGE BATTERIES IN CENTRAL STATIONS.

AN American electrical engineer, recently in Europe, has carefully enquired into the reason for the large use of storage batteries in English central stations, and their almost complete absence from the United States. He says that he was struck by the smallness of the plants, and the extreme lightness of the loads during certain periods of the 24 hours. The load diagrams "were generally Alpine in the sharpness of their peaks and the sheer depths of their valleys." Such unequal outputs are, he says, evidently suited for a battery service from about 3 a.m. till 9 a.m.; but strange to say, he did not discover a single instance in which the batteries were used as an auxiliary to relieve the dynamos at maximum output, or to run the lamps at light load.

Another point that impressed this gentleman was the undue proportion between the batteries and the generating plant; in some cases the dynamo room being even insignificant compared with the work expected. He was also struck with the care bestowed on "sick" cells, and says "that the American engineer, on the contrary, heaves a troublesome battery into the scrap-heap, and makes an assignment."

We do not know the name of the gentleman who has favoured the *Electrical Engineer* of New York with the preceding wholesale judgment of European central stations; but we guess that in his hurry to "do the round trip," he has neither done himself nor his attempted work justice.

If he will, at his leisure, study some of the load diagrams already published for some of the smaller stations, he will see that the part played by the battery is really a most important one; that it not only economises the capital outlay, but largely reduces the standing charges for attendance. As for care and attention, it is now thoroughly recognised, notwithstanding this gentleman's opinion, that the most economical method of dealing with machinery is to keep it in as high a state of efficiency as possible. It is more than probable that the coal bill of some of the small stations, so disparagingly criticised by him, would show a far lower consumption of fuel per unit delivered than many of the American stations.

We, ourselves, are fully alive to the weak points in accumulator construction, but these are not so apparent in lighting as in traction work, and a depreciation of 15 per cent. is certainly sufficient to cover the cost of maintenance with central station batteries. And this sum is more than saved by the advantages derived from their use. Again, the importance of the accumulator as a stand-by against temporary accident to machinery should not be overlooked, even if it be regarded only from the confidence it gives to the consumer. As for the engineer who would heave a troublesome battery into the scrap-heap, in Europe he would stand

a fair chance of being heaved out of the place. We are glad to receive the criticism of our friends, but we like them to take the trouble to master the facts of the case before adjudicating.

THE RECOGNITION OF CURVATURE CHANGES BY MEANS OF THE FLEXIBLE LATH.

IN the plotting of curves and in the interpretation of results, much use has been made of the flexible lath. Electrical engineers are addicted to curve drawing and wisely so, of course, hence the following may interest them; it is the substance of a portion of a paper by Mr. S. U. Pickering in the *Philosophical Magazine*.

An exhaustive examination of four series of experiments was made which shows that the use of the flexible lath and of parabolas deduced from the experimental values, leads to the same conclusions as to the existence and position of any changes of curvature. A method was first obtained for estimating the error of a drawing; the mean apparent error of the points. The number of points represented as showing excessive errors, and the arrangement of errors with like signs into groups, were the three factors taken as constituting the total error of the drawing, and this error should be very nearly identical with the ascertained experimental error, if the drawing is to be acceptable. In all the cases investigated by Mr. Pickering, this was so when the drawing represents the existence of the breaks in question; whereas a drawing or parabola which obliterates them exhibits an error many hundred and even thousand times greater than the experimental error.

On the other hand, the introduction of fictitious breaks into a curve, which is really continuous, produces little or no reduction in the total error, and such a drawing can, therefore, not be accepted as the simplest interpretation which is in harmony with the experimental error.

In the case of well-marked breaks, their position cannot be shifted even a short distance without increasing the apparent error beyond legitimate limits. Neither the position nor the existence of these breaks are subject to the "taste" of the draughtsman. In the case of a true break it will appear consistently whatever form of plotting be adopted. Mr. Pickering gives several instances of this. He also finds that in a case where two parabolas, showing a break, and containing together seven constants, represented the results perfectly, a single parabola obliterating the break, but with the same number of constants, exhibited an error twenty-five times greater than the experimental error.

Overlapping Loads.

OUR contemporary *Industries* in treating of "The Future of Electrical Power Transmission," mentions the matter of the overlapping of the motor and lamp load, and confirms the opinions expressed in our articles on the Cantor lectures. It says, "In spite of this overlapping the motor load not only improves the load factor to some extent, but it increases the output of the station with but little extra cost." Tidal dams and windmills as sources of power are summarily dismissed; as for the windmill it may do some small work in its way for amateurs. Tidal dams require immense tracts of land to lay them out; this land has to be paid for, and thus absorbs a great amount of capital; indeed, we have heard it stated as a fact that the land required to work a tidal dam power would yield more profit if laid out to grow cabbages. Our opinion is that the future developments in electric power transmission and its profitable distribution depends to a large extent on the possibilities of improving storage of electricity.

The Telephone.

ONE of the drawbacks of the holiday season is the interruption which takes place in newspaper controversies, and the consequently belated replies of contending correspondents. The *Times* of the 13th inst. contained further letters from Mr. Faithfull Begg and General Webber, continuing the subject raised by the Duke of Marlborough on the 23rd ult. It will be seen from these letters, published in another column, that Mr. Begg maintains the position which he had taken up, and General Webber, in a tone of genial banter, is so merciless as to confront the Duke with his previous arguments, and those of his friends. In this triangular duel it is possible to award some degree of victory to each combatant. However much we might wish it to be otherwise, it is useless, as we have so often urged, to overlook the difficulties and disadvantages of telephonic competition, and the Duke of Marlborough is, to a great extent right in the views he now expresses on those points. Mr. Begg has certainly established the contention which he maintained on the one point to which he drew attention; and General Webber demonstrates beyond question the impossibility of reconciling the Duke's arguments and attitude now, with those previously held. We think, however, that it would be wrong to lean, as General Webber is apparently rather inclined to do, to the conclusion that the previous arguments were right. The simple facts seem to be that certain persons were engaged in a commercial transaction, and indulged in certain sanguine views, which tended to promote the interests of the commercial transaction. The views were loose, vague, and unprofitable, but they served their turn. The old lion and the young lion have arranged to gobble up the public between them as we said they would. It pleases the Duke of Marlborough to turn our roaring young lion into a bleating young lamb, but the alteration in the zoological definition does not alter the circumstances. We are inclined to urge that the bleating of the lamb should be taken *cum grano salis* to the same extent as the roaring of the young lion.

Importing Submarine Cable.

THE following is interesting and instructive as showing the position which the submarine cable manufacturers of this country hold in the estimation of our friends on the other side of the Atlantic:—Under the new McKinley tariff law, importations by the U.S. Government are no longer free of duty. As the result of these changed conditions, says the New York *Electrical Engineer*, "Prof. Harrington, Chief of the Weather Bureau, informs the Secretary of the Interior that the cost of the cable for two proposed weather signal stations on islands in Lake Huron is doubled. His original estimate of the cost of seven miles of cable was $10,500 or $1,500 per mile, but he now wants $21,000 or $3,000 per mile, to meet the additional cost on account of the duty. Aside from the point that this would seem to indicate that the consumer pays the tax, and not the foreign manufacturer, we would respectfully inquire what is the use of the duty, if the Government is still to go abroad for its submarine cable? Either the manufacturers here can make this cable, or they cannot. If they are able to make it, we object most decidedly to any purchase of foreign cable. If they cannot make it, or do not care to make it, the duty should come off, as it is certainly then a useless and senseless tax, like many others that the tariff imposes. We believe that this country is able to make

its own submarine cable if it chooses. What do the manufacturers say?" Writing to the *Electrical Engineer* in response to the latter query, three several manufacturers practically say that the Government should not go abroad for its submarine cables, but the full texts of their letters very much qualify such assertions. Mr. Briscey, the manager of Day's Kerite Works, however, simply states that "their facilities are such as to meet every practicable requirement," a statement which does not go for much, since it simply indicates that the Kerite Works are willing to *try* what they can do. Mr. Henry A. Reid, of the Bishop Gutta-Percha Company, states: "It is true that there are no manufacturers in the United States capable of making the long ocean cables, as that requires *ships* to lay, as well as factories to make, and since iron wire is the largest item of cost in the long cables and that is much cheaper in Europe than in this country, as are also the labour and the ships, the long cables cannot be made here. We would be very glad of the order to make and lay the Lake Huron cable at $1,500 per mile now; and we have just offered to make for 10½ cents per foot, $554.40 per mile, 12 miles of cable for life-saving stations; and the English in this case beat us at that." Finally we have a letter from Mr. W. M. Habershaw of the India-rubber and Gutta-percha Insulating Company, in which it is stated that the difficulty is owing to gutta-percha core being specified for instead of India-rubber. Practically so far the correspondence shows that cost of material and labour, and also inexperience (for if manufacturers had had experience of cable manufacture the government would presumably know of it, and would not ignore the fact), are the stumbling blocks. These facts are worthy of note by our manufacturers.

Fire Insurance Rules.

THERE is undoubtedly much inconvenience caused by the variety of rules which exist amongst fire insurance offices with reference to electric light installations. It is not that any one rule can be said to clash directly with another but rather that the rules differ in stringency, so that, although if the most stringent rule be taken as a guide all offices will practically be satisfied, yet if the least stringent be adopted, the requirements of some office or offices would not be met. Opinions may differ as to whether the rules most widely adopted, namely, those of the Phœnix office, are the best; they certainly, however, fulfil most reasonable conditions, and would probably be still more generally accepted, were it not for the perhaps not unnatural feeling that every office must do something to show its originality by framing its own rules, which shall in some respects at least, differ from those of every other office. In America, recently, an important meeting of electrical insurance experts was held for the purpose of discussing and adopting a uniform code of electrical insurance inspection rules and reporting the same to the various associations and companies for adoption. A draft scheme was prepared which was to be printed and circulated for further opinions, after the receipt of which a final set of rules will be drawn up and reported for adoption. It is not announced that there have been any dissentient voices on the matter, but we should hesitate to say that were a similar convention assembled in this country, such dissension would not arise. There are certainly many rules adopted by all the insurance companies which are practically the same, and as regards those rules which differ in respect of stringency, such for instance, as the lowest limit to be allowed for the insulation of an installation, the most stringent should be adopted, for no limit can be too high provided it is reasonably possible to work to it. When an apparently too stringent clause is inserted in a specification, the contractor at first asserts it is impossible to work to it, then (upon a refusal to relax the conditions) he finds that with considerable difficulty he may just be able to comply with it, and finally that after all it can be worked to without any trouble, the will to do it having developed a way; this we have known to be the case in more than one instance. So in framing a set of regulations one should not entirely be guided by what it has been found possible up to the present to effect, though, of course, existing practical experience must be a chief guide; this practical experience, however, being that of men of real authority and not that of contractors who wish to keep the standard low, so that they may put in inferior work.

Electro-therapeutics.

THE series of articles in this journal on the "Current that Cures" concludes this week with a suggestion which we hope will not pass unheeded. Mr. Newman Lawrence has made out a strong case and though his writing is not without indications of the bias of an enthusiast, we see no reason to doubt the accuracy of his main conclusions. It appears to us, therefore, that the establishment of a school of training for medical electricians would be a decided step in the right direction. A move by which increased accuracy and improved methods are encouraged cannot fail to be advantageous to any branch of science, and especially so to one circumstanced as electro-therapeutics now is. We hold strongly the opinion that the medical authorities would do well to take active steps to expose the serious amount of quackery which now disgraces this subject, and further, that the State ought to do something to protect the public from the swindlers who now prey upon it so largely under the cloak of medical electricity. The establishment of such a school, if properly controlled and conducted, would do much to promote this end. Medical men would by its means be furnished with a body of well qualified electrical assistants. The public would feel increased confidence in *bonâ fide* medical electricity, and last, but by no means least, spurious electrical appliances and all who deal in them would be speedily relegated to the limbo of obscurity, while many thousands of pounds now spent annually on worthless so-called electrical remedies would be diverted to their legitimate receivers—the medical men. We recommend the proposal to the notice of our medical contemporaries, and trust they will give it the consideration it deserves. The traditions of an honourable and honoured profession must, of course, be respected, but it seems to us that a school of training, such as Mr. Lawrence has outlined, in no way clashes with medical interests, while, at the same time, it offers a way out of a difficulty that few will deny the existence of and which many feel to be very serious.

An Experiment in Electrolysis.

IN a recent investigation W. F. Hall passed a steady electric current, averaging about 11 coulombs per day, through dilute aqueous nitric acid of specific gravity 1·069 at 20° C. for 84 days. The electrodes were arranged in separate vessels connected with each other by means of a siphon filled with the electrolyte, and the gases were collected separately. The rate of evolution of hydrogen at the cathode showed a remarkable variation; it gradually diminished and on the 59th day it quite disappeared. The evolution of gas could always be temporarily and largely increased by stirring up the contents of the vessels. The specific gravity of the electrolyte steadily diminished to 1·034 at 27° C. owing to the reduction of the nitric acid to ammonium nitrate, the formation of which took place slowly at first, but afterwards with increasing rapidity. At the anode the rate of evolution of the oxygen was at first much greater in proportion than that of the hydrogen at the other electrode. In a few days it decreased to the normal amount and continued to diminish right up to the end of the experiment. As in the case of the hydrogen, the evolution of oxygen could at any time be temporarily and largely augmented by agitation. The specific gravity of the electrolyte steadily increased to 1·079 at 27° C., owing probably to the conversion of the acid into orthonitric acid.

THE SPEED OF PROPAGATION OF ELECTRO-MAGNETIC UNDULATIONS IN INSULATING MEDIA.

A CONSIDERATION of the property of homogenity leads to a relation of extreme simplicity concerning the propagation of electro-magnetic waves in different insulating media. Suppose an electric oscillator formed of any good conducting metal: the waves which it is capable of emitting, when it is acting in a certain medium, have a length which can only depend upon the form and the dimensions of the oscillator on the one hand, and on the electrical properties of the medium on the other. This medium being assumed to be of an insulating nature, its electrical properties are defined, by an unique coefficient, its dielectric constant or its specific inductive power, K, since the magnetic constants of all known dielectrics are practically equal. It follows, therefore, that λ can only be a function of a certain number of wave-lengths serving to define the form and magnitude of the oscillator and of the coefficient, K. On the other hand, the numerical value of K depends upon the unit of time (the dimensions of K are $L^{-2} T^2$), which may always be chosen arbitrarily; it is, therefore, impossible that the expression λ, which is a length, can contain K. Hence, *an oscillator being given, the length of the waves which it is susceptible of emitting ought to remain the same whatever may be the nature of the insulating medium in which the experiment is made.*

Mons. R. Blondlot has verified this proposition in the case of liquid dielectrics; electric waves are produced and transmitted (by the process described in the *Comptes Rendus*, cxiv., p. 283, 1892) the length of two parallel copper wires each distant about 8 cm. from a copper resonator, analogous to that which he has used in determining the speed of propagation of electric waves; that part of the resonator which forms the condenser being contained in a glass vat, whilst that portion of the wire which transmits the undulation is situated in a wooden trough 4 metres long. The vat and the trough being free from liquid, the bridge is moved about until the proper *locus* is found at which the spark disappears; the distance of the bridge from the resonator is then one-fourth of the length of the wave which the latter can emit. This done, the glass vat is filled with the liquid selected for experiment; the length of the wave becomes much greater. The trough is filled with the same liquid, and, in searching for the new position of the bridge for which the spark will disappear, Mons. Blondlot has found that this position is exactly the same as in the first part of the experiment, when the vat and trough both contained air.

Mons. Blondlot has obtained equal success with two dielectric liquids, namely, essence of turpentine and castor oil; he considers, therefore, that the verification of the law is complete. (But, for all that, it strikes one that he might have made a more comprehensive series of experiments.)

The science of acoustics presents a case entirely analogous to this: a sonorous pipe always emits waves the length of which depends entirely upon that of the pipe, and, accordingly, is independent of the nature of the atmosphere in which it is made to vibrate.

From the above law, Mons. Blondlot has deduced an important consequence, which has already been perceived by Mons. Potier.

Between the capacity, C, the coefficient of self-induction, L, and the period, T, of his resonator, exists the relation:

$$T = 2\pi\sqrt{CL},$$

whence, by multiplying the two sides of the equation by V, the speed of propagation of the waves:

$$\lambda = 2\pi\sqrt{L} \times \sqrt{C} \times V$$

since λ and L are independent of the nature of the dielectric medium, the product, C V, should be also; however, when one passes from air to another dielectric, the value of C becomes K times greater, and the value of V ought to be multiplied by the inverse $\frac{1}{n}$ of the index of refraction of the new medium; hence it is necessary that

$$K \times \frac{1}{n^2} = 1$$

or

$$K = n^2$$

and this is a relation already proved theoretically by Maxwell.

Mons. Blondlot has verified this relation for the two liquids employed in his investigations, and his experiments confirm those of Herren L. Arons and H. Rubens, published in the Wiedemann's *Annalen*, Bd. xlii., p. 581, 1891. Cod-liver oil offers here a special interest, for when one seeks to deduce from the values of the optic indices of this substance, the index which would correspond to a wave of infinite length by the aid of Cauchy's dispersion formula, the number obtained is 1·4674, whilst the square root of the dielectric constant is 2·18 (*vide* Wiedemann's *Annalen*, Bd. xlii., p. 582, 1891). This looks as though Maxwell's relation is at fault, but it is really the method of verification which is incorrect.

But Mons. Blondlot states that *his* experiments fulfilled to the letter the condition required, so that the Maxwell's relation might be applicable, and had the advantage of being independent of all measurement. He points out, however, that his work refers to dielectric media which are defined by a single dielectric constant; if several coefficients were necessary, the wave length corresponding to a given oscillation would be unable to be independent of the medium, and the Maxwell's relation would be at fault. More experiments in this direction are undoubtedly called for.

POWER TRANSMISSION BY ROPES.

IN treating of the above subject in *Cassier's Magazine*, Mr. Grimshaw deals rather with the system of rope driving as practised in America, than with the English method. The difference between the two methods is that in the English system there is a separate rope to each groove of the main driving pulley. In the American system, which we, in England, usually term Raworth's, there is one long endless rope only, several times wrapped round the main pulley, and taking several turns, if necessary, over each driven pulley. The obvious fault of this system is that a single break destroys the whole system, whereas in the English system a rope may break, and there may not be a minute lost as a consequence.

Though we would not be understood to advocate a general return to toothed gearing, regard for the truth compels us to differ from the author in what he has to say as to the great friction, noise, and backlash of even the best designed toothed wheels. Noise and backlash are by no means inseparable from even cast gears, and we could take the author to places in England where all-cast gears are running, for practical purposes, noiselessly.

Apart from this, moreover, it is a matter of common knowledge among the English millwrights that the indicated horse-power necessary to drive, say, 50,000 spindles through ropes, is five, if not ten per cent. greater than that found necessary when gears are used, and it is usually understood that, in this respect, leather belts occupy a middle position.

As regards the main driving wheel, it is by no means so certain as our author supposes, that wrapping connections call for lighter parts than gears. Certainly the rim pulleys of a modern cotton mill are heavier than an equally efficient toothed rim.

Moreover, we cannot agreee with the statement that gears, as ordinarily made, are not so mated, that all of a pitch will mesh together; for where the epicycloidal form of tooth is employed, it has been for years the practice to use a generating circle of uniform diameter throughout, so that every wheel in a set will gear correctly with any other, the somewhat pedantic employment of generating circles, whose diameter is that of the radius of the opposing wheel, having long since been discarded, except for special cases, or for bevil wheels.

The other objections urged against gears are quite sufficient to limit their use without bringing in non-existent faults. We remember a few years ago how, when belts were superseding gears in America, Americans would cry out loudly about the folly of Englishmen sticking to gears. As a fact, belting never got much hold in England. Our gearing was far superior to that of America, and it required the rope to supersede it, and the progress of rope-driving has

been very much quicker here than it has been in America. Indeed, it is only now that Americans are really beginning to recognise its merits.

In dealing with the variety of ropes employed, those of round leather are described, but there is no reference to the Yorkshire system of square ropes built up of narrow bands of leather to a cross section of about 1½ inches by 1½ inches, each separate band breaking joint several feet, so that no two joints come together. These Yorkshire belts are found running in grooves of semi-circular section, and present great facilities for taking up when stretched, and we have found that very satisfactory splices are made simply with wire nails. Where wire rope is used, we are told that a bar to its more extended use lies in the splicing difficulty and the avoidance of projecting wire ends. It is not everyone can splice a wire rope, but there is not, after all, so much difficulty in the operation. The correct splice is of course that performed by unwinding a strand from one of the junction ends and laying in the groove the unwound strand from the opposite end. In a wire rope of ¾ inch diameter Messrs. Craddock, of Wakefield, would extend the splice a matter of 70 feet, and would get over the difficulty of the ends by opening the rope, removing a short bit of the internal core, and pushing the end of the strand into the vacancy left. Such a splice has the same diameter as the body of the rope, and is not easily found by an untrained eye.

In giving 600 feet as the speed per minute for wire ropes, we presume 6,000 were meant by Mr. Grimshaw.

The combination of wire and leather, as seen in the wire rope, on which are closely packed leather discs receives no mention. The leather, it is true, adds to the centrifugal tension without adding to strength, but it admits of every rope on a drum being run upon round bottom grooves of exactly equal diameter, and we have found such ropes giving great satisfaction. The fibre rope, run in a wedge groove, has the fault that every rope on a wheel may be running upon a different diameter, and to this is often attributed the excessive friction of rope driving as compared with gears or even belts, and this fault will be equally marked in the American as in the English system.

The reduplication system has the advantage of only one splice, and thus admits of ropes being taken up easily for slackness; but the system of sliding frames does not commend itself as very neat, nor do we consider it good practice to run ropes vertically between shafts, though with the single rope there is stated not to be any trouble in the way of slipping.

The author is of opinion that the maximum speed of ropes has not been reached, but 6,000 feet per minute is common, and he would not hesitate to run soft ropes at 10,000 feet per minute if other considerations permitted. With the working tensions allowed in practice, however, the centrifugal tension due to a speed of 9,000 feet is more than sufficient to absorb the whole of the available allowed strength, so that unless a very much higher tension be allowed, speeds of more than 5,000 feet are useless, if not actually mischievous. A 1-inch Manilla rope has a strength of 7,000 pounds, and is worked, in an example given, at a driving side tension of 204 pounds. It drives 450 H.P., and takes 14 turns about the pulley. Its speed is nearly 5,200. The driving side tension must have been, however, more than 204 pounds, for it is not merely the working tension but the sum of this and the slack side tension. For fibre ropes it is not customary to run the ropes upon the bottom of the groove, and certainly the action of an angular groove is towards largely adding to the gripping action of the ropes. At the same time, if it could be shown that a sufficiency of grip could be obtained with the ropes bedding in semi-circular grooves, as is done with the leather-covered wire rope, we see no reason why the system should not be adopted, or at least tried, and the reduced friction determined, if such exists, as there appears every reason to believe it does. To our mind, it appears that the American system of a single rope is much more suitable for secondary driving than for main driving. Its capacity for direct vertical action is not of value except in secondary work, whilst for main driving the advantages of the English system are too great to be over-weighed by this consideration. The American system seems to be based upon a mistaken idea that ropes need to be very tight in order to work. This ultra-tightness is quite unnecessary, and, in the practice of the textile mills, ropes are often allowed to sag until the slack side, when running, nearly comes into contact with the driving lower side, and the substantially-horizontal position affords the means of working slack ropes, which are generally considered better than tight ropes, just as the tightness of a belt is best made such that greater slackness would cause slipping. Indeed, it may be laid down almost as an axiom that unless a belt or rope will do its work with plenty of slack, it is too small for the duty demanded of it; and this desirable condition is, of course, out of question when shafts placed in a vertical line have to be connected by ropes, and the complication of rider pulleys or sliding frames comes in.

THE REPRESENTATION OF ALTERNATE CURRENT AND ELECTROMOTIVE FORCE CURVES.

DR. LOUIS DUNCAN has communicated to the American Institute of Engineers a novel and practical method of plotting simultaneously the primary and secondary curves of current and pressure. There is no need to comment on the important bearing of such a device. Joubert was the first to show these curves. He employed a contact piece, rotating with the armature of the dynamo, touching a fixed brush at a point of the revolution determined by its position with reference to the field magnet poles. The chief objection to this method is, that since only one contact is used, only one curve can be plotted at a time, and so it is not practicable to get the pressure and current curves at the same time. It has, however, been recently improved in France by a modification, involving two commutating arrangements, and a condenser charged and discharged through a d'Arsonval galvanometer.

Dr. Duncan's plan is capable of application to any number of curves, if sufficient dynanometers are to hand, and hence simultaneous readings can be made by different observers, and the whole of the required curves plotted together. The dynanometer used is made of wood, mounted on a revolving base, to facilitate adjustment. The fixed coils are wound in two cylinders, movable in their seats, for the calibration of the instrument. The movable coil is suspended on a cocoon fibre, and directive force is given to it by two palladium hair springs. A glycerine damper is fixed below, in which vanes attached to the coil are immersed. The instrument is said to be absolutely aperiodic.

The method of coupling up and taking the readings is as follows:—The movable coils, which all have fine windings, with small self-induction, are coupled in series. A non-inductive resistance, so large, that the resistance of the coils may be neglected, is put in series with them, and then joined to one terminal of a few storage cells. The other pole of the battery is coupled to a brush, which can be rotated by hand through the arc of a circle concentric with the shaft of the dynamo under test. On the shaft is a flying brush, which makes contact with the movable brush once during each revolution. The instant of closing the circuit is determined by the position of the brush with respect to the poles of the dynamo field. The alternating current, whose curves is to be traced, is passed through one of the fixed coils; or if it be desired to plot a pressure curve, then the coil is coupled across the source of supply, giving the electromotive force to be measured.

Now, if the stationary coils be severally connected to the primary and secondary terminals of a transformer, as above directed, and an instantaneous current be sent through the movable coils, impulses will be given dependent on the value of the currents and pressures, and the instantaneous value of the current in the movable coils. And as the periods of the swinging coils are great compared with the period of the dynamo, a steady deflection is produced. If the contact brushes be shifted, relatively to the field poles, the instantaneous current will pass at some other part of the alternation, and the deflection will again be proportional to it. By a sufficient number of readings the complete curve can be easily and quickly plotted. The dynamometer requires careful calibration, and it is evident that the current in the movable coils must be kept constant both as to the time of contact and the value of the current.

To judge these two points, a d'Arsonval galvanometer is

placed in circuit, and it is found that when a high resistance is used in the combined circuit, so that any variation in the contact resistance is eliminated, almost absolute steadiness is obtained. As a further precaution, Dr. Duncan used a condenser which was charged during part of the revolution, and then discharged by the contact of the revolving brush through the circuit. The current used in the movable coil circuit was, with no condenser, that due to 12 volts through 1,000 ohms, and it must be remembered that this current only passed for an exceedingly small interval of time per revolution.

Some very interesting curves of a Tesla fan motor, loaded and running light; of a step-up transmission plant; of a dynamo running a bank of lamps, and then working as an inductive resistance; &c., serve to show the large field opened up by the new device.

Few of us have very clear notions of alternate current working, and this graphic means of representing the actual phase and magnitude of current and pressure must tend not only to familiarise us with these relations, but also to largely improve the apparatus used in connection with alternating currents.

ELECTRIC DISTURBANCES FROM STREET RAILWAYS.*

By PROF. WHITMAN, of Adelbert College.

DISTURBANCES were noted for some years at Adelbert College laboratory. A year ago it was suspected that they were due to the electric road passing the college.

The laboratory stands about 500 feet from the railroad. The road has a heavy traffic, and the current in the feeders passing the college averages about 300 ampères, though with great fluctuations.

The first experiment was made by methods used by Ayrton and Rücker in experiments with the City and South London Railway, similar to some of those detailed in this paper. Magnetometer and non-magnetic needle, of like shape and weight, with bifilar suspension, were set up and adjusted till periods were the same. Observations of each were taken at intervals for several days. The non-magnetic needle was perfectly steady, the magnet never at rest.

The magnetic field at this distance from the road should be nearly perpendicular, and should affect the needle but slightly. Similar magnetometers, adjusted to the same period, were set up in the laboratory on the third floor and in the basement, and observed at corresponding times, every 10 seconds. Results show that the needles are disturbed in opposite directions, showing that the iron in the building, steam, gas and water pipes, was magnetised perpendicularly.

During all these experiments, passing, stopping, and starting of cars was carefully observed, but no relation whatever could be traced between these and the magnetic perturbations.

Also observations were taken after midnight, when cars go by the college but once an hour. The general position of the needle differed by several scale divisions from that in the daytime, showing that there was a permanent deflection due to direction by the current, but the perturbations, erratic swings, changes of zero, &c., were about as great as in the daytime. Hence the disturbances are due mainly to the current acting on the iron in the building, and not to passing cars.

The magnetometer was set up in a barn at a distance of 300 feet from the track. Here there was no iron. The disturbance was about two-thirds that in the laboratory. The influence of passing cars was plainly noticeable. This was perhaps to be expected, as the action of the cars would vary as the distance squared, and not like the line action, simply as the distance.

If conditions had been the same in the barn and laboratory the disturbance in the laboratory should have been three-fifths of that in the barn. Actually, it was one and one-half times as great.

As to results:

No magnetic instruments dependent on the earth's field can be used for reasonably accurate work at less than about 1,500 feet from such a railway as the East Cleveland Railway, and the distance must be made greater still if the building in which the instrument is placed is fitted with a system of iron pipes. Mirror galvanometers must use non-magnetic shields and artificial shields, while earth inductors and other similar methods of finding the constant of a ballistic galvanometer must be abandoned.

It is, of course, easy following Sir William Thomson's lead to devise methods for all such work which shall be wholly independent of the earth's magnetism.

Experiments are now under way for finding the thinnest shield of soft iron which will serve as a complete protection to magnetic instruments under such conditions as those stated above.

* A paper read before the American Association for the Advancement of Science at Rochester, N.Y.

THE HALLE ELECTRIC TRAMWAY.

THE Allgemeine Elektricitäts Gesellshaft, of Berlin, some months ago installed at Halle on the Saale, an overhead electric tramline, which has been since then in continuous operation, giving satisfaction both to the public and to the tramway company. The line is very hilly, and has grades as steep as 1 : 21. There are three sections, served with 25 motor cars and 25 of the old horse cars which are used as "trailers."

The cost of the equipment, including motor cars, overhead conductors, central station buildings and machinery, came to £30,000. The buildings were adapted from the horse car depôt.

The steam power is furnished by three water tube boilers, two of which give sufficient steam for the work, the third being in reserve. The fuel used is the brown coal of the Halle district.

There are two non-condensing compound engines, each giving about 123·4 effective horse-power at 120 lbs. pressure, and at 150 lbs. one engine will give over 200 horse-power which is sufficient to run the total number of cars. The engines are of a somewhat peculiar pattern, designed to save space. The high pressure cylinder is horizontal, 13·5 inches in diameter by 21·625 inches stroke. The low pressure cylinder is vertical, has a diameter of 20·0625 inches and a stroke of 21·625. Both connecting rods are coupled to one crank. Each engine drives by belting two 4-pole shunt-wound dynamos, giving 500 volts and 120 ampères each, at a speed of 520 revolutions per minute. The current is taken to two collecting bars on a switchboard, one of which is joined to the tram rails by means of a bare copper wire placed underground. The other goes to insulated conductors or feeders, run overhead in the wider streets and underground in the narrower ones. In the earth circuit is an ammeter reading up to 800 ampères, and a fuse for the total current furnished by the combined dynamos.

In the circuit of each feeder are switches by which it can be cut off from the collecting bar. The dynamos are coupled in parallel to the two bars with fuses in each main, and can be separately switched off or on. An ammeter is placed in each dynamo circuit, and one voltmeter is arranged to read, by means of a two-way switch, the pressure of either of two dynamos. The D.O.P. at the end of the feeders is controlled by resistances in series with the field magnet windings.

The trolley wire is silicium bronze, about number 4 B.W.G. in size, and possesses a tensile strength of 28 tons per square inch. It is stretched so that even in the hottest weather it is 18 feet above the street level. In the narrow streets the span system is used, and in the open roads the trolley wire is carried from iron lattice poles, which also carry the feeders. These are at intervals attached to the bare trolley wire so that the latter has only to carry the current for one car.

The change from one line to another is done by switches, made in aluminium for the sake of lightness. The gauge of

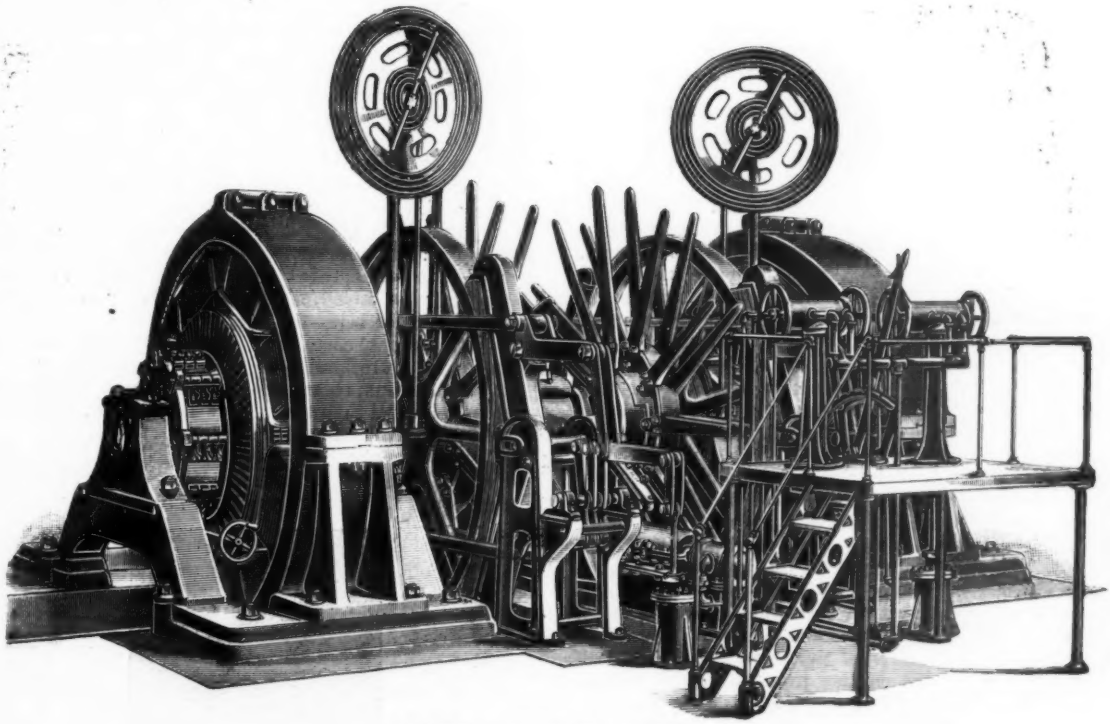
the line is 1 metre, the sharpest curves from 39 to 49 feet; and the wheel bases of the cars are 1·5 metres, or 5 feet nearly.

Each motor car has two motors, one end of each motor being carried on an axle, and the other on springs. The brushes used are carbon. The motors run at 1,150 revolutions per minute at full speed. The gearing consists of two sets of spur wheels, the pinions in aluminium bronze and the wheels in cast-iron. All the teeth are cut and the wheels run in oil baths, being completely encased in metal boxes.

The switches, with their mechanism, are contained in boxes fixed to the front and back of the car; they consist of vertical wooden cylinders, having contact pieces on the top surface. The regulation of speed is effected by altering the couplings of the field magnet coils; but the armatures are apparently always kept in parallel. The motors are of the regular Sprague railway type.

The tramcars carry no conductors; the fare is fixed at 10 pfennigs for any distance and is collected by the driver.

As will be noted in this brief description, for which we are indebted to the *Railway World*, the line closely follows American practice in all the essential details, and the success which has attended it shows that the overhead system of electric tramways is quite suitable for European service.



1,000 H.P. ELECTRIC WINDING ENGINE.

THE NEW DIRECT-ACTING ELECTRIC WINDING ENGINE OF THE THOMSON-HOUSTON COMPANY.*

WHEN we have to draw minerals from very deep mines, it is most important to consider the speed of the cage, especially if the daily output be considerable.

A winding-engine, driven by steam, comprises essentially a machine capable of driving in either direction a shaft upon which is mounted two drums or bobbins and a friction brake. Two flat or round ropes are wound around the drums, passing over the head-gear pulleys placed over the pit, and thus carry the cages which hold the minerals.

When the speed at which the cages are moved is very great, the shaft of the drums is coupled direct to the crank shafts. When the motive machine has only one cylinder, and the mean speed of the cage does not exceed three or four metres per second, the drum shaft is geared by a pinion and wheel to the crank-shaft, the latter also carrying a fly-wheel.

The use of gearing permits of high-speed engines without unduly raising the speed of the rope during the ascent and descent of the cage. But this method of driving has limiting conditions of speed and safety, and is generally confined to winding from shallow pits. For great depths coupled engines are preferred, the two cranks being connected direct to the drum-shaft at right angles to each other.

Winding-engines are ordinarily of horizontal or vertical type, and sometimes the cylinders are inverted. Coupled machines have, when arranged with gearing, a shaft which carries the drum and the brake-wheel, but there is no fly-wheel, since the cranks are placed at right angles. The horizontal arrangement occupies a considerable amount of room, and the drum-shaft is generally very close to the pit. It follows then, that, excepting where there is plenty of room, the ropes make a small angle with the head-gear pulleys, and thus the bending moment is considerable, and the life of the ropes is shortened. Vertical engines offer an advantage as regards the floor space occupied, where there is little spare room; but if they are near the pit, it is necessary to raise the drum-shaft, in order to increase the angle of inclination of the ropes.

These rapidly sketched conditions show some of the common problems relative to the construction and erection of steam winding machines.

The electrician attempts a totally different solution of the problem. Let us look at what has been done, in this particular domain, by the Thomson-Houston Company. The block shows a perspective view of one of these machines, arranged for flat ropes.

Upon the drum-shaft, at either end, is mounted the armature of an electric motor, capable of an output of 500 H.P., so that their combined power is equal to that of 1,000 horses. The machine is designed to raise a load of 4,500 kilogrammes from a depth of 800 metres in a minute. This is the maximum speed, but it can be fixed at pleasure at lower limits when raising men or for any special purpose. The lowering can be effected by the motors alone, without using the brakes, if at any time it is desirable to work in this way.

In the space between the motors, the two brake pulleys and the two drums for the ropes are symmetrically arranged about the centre line. The shaft for the drums has been

* From *L'Electricien*.

designed to resist unforeseen shocks. Ordinarily, it is supposed to withstand, at the centre, a load equal to three times the maximum working strain on the drum—a strain composed of the dead weight of the useful load and of the weight of the ropes, and the size of shaft is calculated so as to resist the bending moment due to the triple effort. The iron is worked at 375 kilogrammes per square centimetre, and allowance is made for the moment of torsion.

The brake is intended to develop sufficient friction to destroy the momentum of the moving mass and so stop the machine. In powerful machines, the brake is furnished with two jaws, acting in opposite directions, and producing friction, without causing a side thrust in the shaft. The blocks are applied simultaneously upon the faces of the brake pulleys, by means of levers passing above and below the shaft. Jointed in a parallelogram, these rods move always parallel, and thus the jaws are applied at two points equally distant from the centre of the shaft. The blocks are pivoted at their centre, so as to adapt themselves exactly to the curvature of the brake-wheel. The brake-blocks are designed to give three times as much friction as is necessary to overcome the load, so that the machine can be stopped instantly. The coefficient of friction between wood and cast-iron is assumed to be constant, because of the contraction which is continually going on.

The brakes are worked by compressed air, supplied from two little cylinders lying vertically under the sole of the machine. Air is delivered to them from a small compressor, driven by an electric motor. The connecting-rods from the pistons act on parallel motions, which transmit the thrust to the jaws of the brakes.

The compressor does not require supervision; it is automatic. It stops itself when the pressure in the reservoir, forming its base, reaches a certain point, and acts quite independently of the winding-engine.

As is always the case with winding-engines, the driver is placed on a raised platform, reached by a ladder, where he can see all parts of the machine, and regulate its action. He has to the right and the left of him two small hand wheels governing the admission valves of the compressed air brakes, and also the exhaust when the brakes are removed. The reversing gear consists of a lever which rides between the plates of a toothed sector, similar to the guides in the reversing levers of Gooch or Stevenson. The movement of this lever changes the direction of the current in the armatures.

The electric-motors have eight poles, with Gramme ring armatures. It is superfluous to add that special care has been taken to secure high insulation not only between the conductors, but also between them and the frame. The brushes are multiple, and are rocked by a worm and wheel. The worm is driven by a little hand-wheel below the commutator. This is clearly shown in the design. The lubrication is automatic. The position of the cages in the shafts is shown by a disc indicator, around which moves an index. A pin which carries this index is arranged to travel in a spiral groove, cut in the face of the discs. The index itself is driven by a worm cut on the drum-shaft; this engages a corresponding toothed wheel, which is carried by a vertical shaft going up to the disc.

To conclude, here is a very powerful machine occupying only one-half of the space usually required for steam winding-engines. We have taken the trouble to show the general features of the two kinds of winding-machines, so that the advantages secured by the use of electricity may be the more easily seen.

SOME NEW STANDARD CELLS.

UP to the present no standard cell suitable for use in the measurement of small potential differences has been described, hence a recent suggestion by W. Negbaur merits some attention. From some experimental results obtained in an investigation in this direction, he has been led to advocate the employment of cells in which there are two solutions of the *same* chemical substance (acid or salt) each in a different state of concentration, the electrodes being composed of mercury coated with calomel (*i.e.*, mercurous chloride, Hg_2Cl_2.)

The substances used in these cells can all be readily obtained in the pure condition. The difference of potential can be regulated or altered within wide limits by modifying the degree of concentration of the two solutions; moreover, this can be calculated beforehand.

A useful form of Negbaur's new cell is shown diagrammatically in fig. 1.

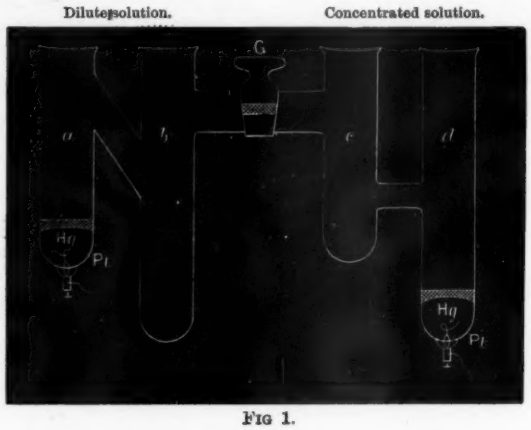


FIG 1.

The more highly concentrated solution is placed in the right hand portion of the apparatus, the weaker solution in the left hand portion. The tubes, *a*, *d*, contain the mercury coated with calomel paste which form together the electrodes. The tubes, *b*, *c*, provide for any overflow of solution from *a* and *d*, and in these tubes may be placed small thermometers if necessary. It is only necessary to retain the original concentration at the electrodes. Platinum wires are sealed into the lower ends of *a* and *d*, and are placed so that they communicate with the mercury. G is a glass tap perforated with a hole through the plug which contains a little roll of parchment paper: the tap serves to separate the two solutions from one another. Hydrochloric acid and sodium or lithium chlorides are suitable for establishing the "concentration current," the acid being the best.

From solutions containing respectively 4·00 and 0·99 grammes of hydrochloric acid per litre, or 2·5 and 0·1 grammes of sodium chloride per litre respectively, a difference of potential equal to 0·1 volt may be obtained, which will remain perfectly constant for at least eight days.

Further particulars concerning this cell may be found on consulting Negbaur's paper in the *Annalen der Physik und Chemie*, series 2, Vol. xliv., pp. 767—770.

FIG. 2.

This physicist has also suggested an improvement in the Latimer Clark standard cells which deserves a short notice. In connection with this type of cell various objections have been urged, chief amongst which are (*a*) the presence of a porous pot, in which the sulphate of zinc is frequently deposited in a crystalline condition, and (*b*) the necessity for using a somewhat larger quantity of mercury, in order that when the cell is disturbed the end of the platinum wire that is immersed in this metal may not become covered with a film of mercurous sulphate Hg_2SO_4.

Negbaur considers that these objectionable features may be dispensed with by employing a cell of the form shown diagrammatically in fig. 2.

In this cell the mercury is contained in the U-tube, *a*, *b*, into the shorter limb, *a*, of which passes the platinum wire, whilst the other limb, *b*, holds the paste of mercurous sulphate.

The side tube, *c*, contains the small zinc rod. The opening by means of which it is connected with the tube, *c*, is made as large as possible, consistent with the strength of the apparatus.

The solution is covered with a thin film of vaseline, which has the effect of entirely preventing the formation of crystalline sulphate of zinc.

It is necessary to coat the cell with black paper, in order to protect its contents from the deleterious action of light.

The internal resistance of Negbaur's modified form of "Latimer-Clark" is somewhat higher than that of the original type.

The total height of the new cell is six centimetres. It is described more fully in the *Annalen der Physik und Chemie*, series 2, Vol. xliv., pp. 765, 766.

SPOKANE ELECTRIC RAILWAY SYSTEM.

THIS compact tramway is very typical of successful American plants, and shows how fully the overhead system meets the requirements of a service between city and residential districts. There are in all twenty miles of double track, two of which, recently acquired by the electric company, are worked by cable. The Spokane Electric Railway Company purchased the plant and franchises in 1889, at which time the lines were served by horse-cars owned by private people. They rapidly extended the lines into all the residential districts, and as the car speed is as high as twenty miles per hour, the suburbs may be said to have been brought nearer the business centre of the town. The track is laid with 40 lb. steel rails, where the traffic is heaviest; and with 35 and 30 lb. rails on the other portions. The roads are practically level; with the exception of some 500 feet with a maximum grade of 5 per cent., no part of the lines has a grade exceeding 1 per cent., hence the high speed before mentioned. The minimum radius of curves on the system is 45 feet.

The overhead construction is in accordance with best practice. The whole line is divided into four sections, each receiving current from an independent double feeder running direct to the power station where a fuse is placed, so that a short circuit on one section does not interfere with the remaining three. The trolley wire is No. 4, B.W.G. hard drawn copper. An auxiliary main is run parallel to the line on the side poles and feeds into the trolley through insulated conductors every 500 feet. The trolley wire is supported entirely by vice clamps made of cast-iron, and no solder is used throughout the system.

The car equipment comprised 32 cars; sixteen of these are of Brill's manufacture, having "maximum traction" double trucks; nine open summer cars made by the Stockton Car Company, and seven cars of the Pullman manufacture with Bennis trucks. The "maximum truck" has two pairs of 30 inch driving wheels, to which are attached the motors, and one pair of 18 inch wheels in the centre of the truck. 80 per cent. of the load is carried on the driving wheels. By making the centre wheels smaller the body of the car can be placed some 12 inches nearer the ground than with the ordinary arrangement of double truck motors, the smaller wheels swinging clear of the floor beams when passing round curves.

On one of the suburban lines are four small dummy cars, each having two longitudinal seats similar to cable dummies. Each car is mounted with a single waterproof 30 horse-power Thomson-Houston motor equipment. The motorman stands in the centre of the car and controls it from the same point as the gripman in the cable dummy. The axles are coupled by sprocket chains. These little cars are said to run at a great speed, and to give an admirable service.

It is somewhat surprising to find chain gear so successful after the repeated failures in England and on the Continent. But there is this great difference between American and European car work, the moving loads are relatively small, probably not in excess of five to six tons. The power station is driven by water wheels in the Spokane river. There are two 17½ inch Victor turbines of 450 H.P. joint capacity, running with a 50 feet head. These are coupled to four dynamos by belting. A fifth dynamo is run off a pair of 10 inch wheels with almost vertical belting. All the pulleys are fitted with friction clutches, so that any dynamo can be thrown in or out of gear without affecting the others. Woodward governors have recently been fitted and give satisfaction. The connection of the mains is worthy of special notice; the positive is earthed and not the negative as is usually the case. The idea being that since the spark always clings to the positive side of a break, the trolley wheel and not the trolley wire shall be burnt by the flashing caused by bad contacts. How far this will work out in practice remains to be seen, but it will be watched with interest by many railway men. The cable trams referred to are driven by an independent set of water-wheels also located in the power station.

ACCUMULATORS FOR RAILWAY POWER PLANTS.

MR. MAILLOUX has recently proposed an ingenious application of accumulators to compensate the sudden variations of load on tram lines. To quote his own definition, "the method aims to accomplish electrically for the dynamo what the flywheel does in a mechanical way for the engine. It provides the circuit with a kind of reserve fund of energy, that is ready to instantly appropriate any surplus of electric power when the load is light, and to make up the deficit when it is heavy."

The arrangement proposed is as follows:—A small supplemental dynamo, whose armature is driven off the same engine as the main dynamo, is put in series with a set of accumulators, and is then coupled across the terminals of the large dynamos. Its field circuit has a few turns only, and is coupled in series with the trolley wire. When no current is flowing the whole of the current given out by the large dynamo passes through the accumulators and so charges them, and the armature of the compensating dynamo revolves in an idle field. When the trolley current flows the field coils are excited, and the armature E.M.F. is added to that of the accumulators; hence the current passing through the batteries will decrease as the line current increases, and *vice versa*; and when a certain load is attained the compensating circuit will give current to the trolley wire. The particular value of current in the line which will just balance the compensating circuit is easily arranged by varying the number of cells, and the duration of the extra current from the battery is simply a question of capacity.

The idea seems very feasible and, by a suitable proportion between the dynamos and battery, there is no doubt but that the engine and dynamo capacity could be diminished below that now adopted in the United States for street railway work. The chief point is that by this means the output of the engine could be kept practically constant, and so the boilers and engines and dynamos could all be worked at about their most efficient outputs. This would probably lower the coal and water consumptions fully 40 to 50 per cent. below those now obtaining. The capital saved in engines and dynamos would about pay for the accumulators and compensating dynamo. It is obvious that by a suitable switching arrangement the compensating circuit could be broken when necessary, such as when the main dynamo was stopped.

The idea does not seem to be new, but it is treated in a novel way, and certain points of special interest are raised in the scheme. We shall look forward to a trial of accumulators under the conditions supposed, and expect them to give results, not so satisfactory as for lighting perhaps, yet sufficiently so to pay well for their use. There is a world of difference between the treatment of accumulators so used, and that inseparable from cells in self-contained cars.

Electric Lighting at Reading.—The Reading Town Council last week decided to apply for an electric lighting provisional order.

ON AN OBSTACLE TO SCIENTIFIC PROGRESS.*

By Dr. G. GORE, F.R.S.

THE recent recovery of Mr. Waterston's paper from the *Archives* of the Royal Society by Lord Rayleigh, and its publication after having lain there about 50 years (see *Chem. News*, Vol. lv., p. 219), illustrates the less encouragement given in this country to scientific researches containing really original conclusions or phenomena than to any other kinds of such researches.

As scientific researches which are reliable and original are as necessary and valuable as those which consist of accurate measurements without originality, it seems desirable that some arrangement should, if practicable, be made, by means of which such papers as that of Mr. Waterston's (and probably others) would be saved from oblivion, and be, if possible, as completely examined and as fully recognised and published as less original ones. However important a high degree of accuracy of measurement of known phenomena is, the discovery of entirely new phenomena and new truths is essentially more important, for if no new phenomena or truths were discovered, there would be none to be measured. Out of Faraday's simple qualitative discovery of magneoptic action arose Clerk Maxwell's mathematical theory of light.

A great obstacle, however, to the accomplishment of this very desirable object arises from the following circumstances: (1) All new truths require to be expressed in new language; (2) In consequence of the fixity of strongly impressed previous ideas in the brain, new discoveries and conclusions are only fully appreciated by a new generation of men; and (3) As the examiners of scientific researches are frequently teachers of long experience, their ideas are apt to become so fixed by long-continued teaching that, notwithstanding their anxiety to do justice to the authors, they are unable to fully understand the new phraseology and phenomena, and therefore discourage the publication of really original researches. The so-called "conspiracy of silence" of scientific men respecting the reality of new scientific discoveries is simply a result of this fixedness of mental impression; the examiners being men of high ability and integrity hesitate to express opinions of matters which they do not fully and clearly comprehend, and other men of science follow their example and remain silent.

It is largely in consequence of this hindrance and of the almost universal desire of mankind for some *immediate* advantage, that any and every kind of scientific occupation is more encouraged than fundamental original experiment; accounts of inventions and technical investigations are accepted and published as if they were of greater value than the discoveries upon which they are based, and accurate measurements of known phenomena are treated as if they were of more importance than the discovery of new fundamental truths; and the readiness of acceptance and publication of a new truth is often inversely proportionate to its degree of essential importance.

To make laborious and expensive researches, and have them (and especially the valuable experimental evidence contained in them) practically suppressed and consigned to oblivion simply because they are original and cannot be readily understood, is most discouraging and unjust to investigators, a great obstacle to scientific and national progress, and deserves the serious consideration of those publishing bodies who undertake the acceptance or rejection of scientific papers.

Probably the most effectual method of overcoming the difficulty would be for a committee of paid examiners to actually repeat a sufficient number of the experiments, &c., to enable them to arrive at a demonstrable conclusion in each case. This, however, would be an expensive plan, but it would be only a small expense in comparison with that of making the researches themselves, and the importance of the object would justify the cost. The skill and labour required would be too great for unpaid examiners.

The progress of science can never be very satisfactory in this country until this obstacle is removed, nor until scientific men generally treat different problems and truths of science more in accordance with their essential degrees of importance and less according to their extrinsic or *immediate* practical value. Nor will science itself be treated with the highest respect whilst scientific men in general pursue money and trading in knowledge so much more earnestly than knowledge itself. We are all apt to be blinded by the prospect of immediate personal gain, and fail to perceive the deep-seated sources of greater good which lie latent in increased fundamental knowledge. The ideas that immediate personal gain is always the greatest good, and that money is essentially more valuable and a greater source of happiness than knowledge, are only worthy of the darker ages; the greater good, however, takes a longer time to grow. Great good *must* come from new truth, even when we cannot see the way; new facts are the origin of human progress, and great truths are the parents of great uses; there can be no inventions without the facts upon which to base them, and the progress of mankind is greater in proportion as the facts discovered are more comprehensive; for instance, out of the simple qualitative fundamental fact of magneto-electric induction has arisen the dynamo-electric machine and all its world-wide uses. Other similar examples might easily be adduced.

* *Chemical News*, July 22nd, 1892.

SYNOPSIS OF THE HISTORY OF OZONE, 1840 TO 1892.

(*Concluded from page* 351, *Vol. XXX.*)

1888.—Seguy constructs an ozoniser made of several small glass tubes inserted in a larger tube; it resembles the apparatus devised by Babo. The only difference is, that all the inner tubes, which each contain a wire core, are surrounded by wires coiled around them. The wires inside the inner tubes are all connected to one pole of the induction coil, and the wire spirals surrounding these tubes are all connected to the other pole.

In all the ozone tubes the air must be blown by mechanical means; one of Seguy's patterns is vertical, and the air is heated before being ozonised, thus creating a draught.

1889.—Dr. H. de Vars shows at the Paris Exhibition his ozoniser, consisting of two concentric glass bell covers, having one its inner surface and the other its outer surface coated with tinfoil. They are placed under a third glass bell, and the tinfoil of the two internal bells is connected to the poles of an induction coil. They are fitted in the circular grooves of an ebonite stand; two openings allow the inlet and outlet of the air.

A similar apparatus was described by Berthelot in the *Annales de Chimie et de Physique* several years before. It consisted of two inverted bell-shaped vessels, the inner one having its inner surface coated with tinfoil and the other one having its outer surface similarly coated. These coatings were each connected to one of the poles of the induction coils.

——Albin Figuier renews his researches on the action of ozone (See *Année Scientifique*, 1884). The compounds produced are formed in contact with the poles. In the following table, the substance placed second, constitutes the positive pole:—

Air and *sulphurous anhydride* produce sulphuric anhydride.
Hydrogen and *chlorine*: hydrochloric acid.
Nitrogen and *oxygen*: nitric anhydride.
Hydrogen and *nitrogen*: ammonia.
Carbonic acid and *sodium carbonate*: sodium oxalate and formate.
Ethylene and *oxygen*: formic and acetic acids.
Hydrogen and *carbonic anhydride*: formic and acetic acids.
Methane and *carbonic anhydride*: acetic acid.

——Paper by Bichat and Ganz on the production of ozone by the electric discharge; their remarks on the *pluie de feu*, the less the spark is luminous or hot, the less ozone is produced. Where there is no glow there is no ozone.

——B. W. Richardson, M.D., reads, at the Hastings Health Congress, a paper on the "Purification of Air by Ozone," in which he quotes the remarks of Faraday, who had found ozone freely on the Brighton Downs, and had found the evidence of its diminishing as he approached Brighton, until it was lost altogether in the town itself. He adds that the red corpuscles of fresh blood decompose ozone, and that coagulated blood undergoes a degree of evolution through its action. "I put," says he, "dead birds and pieces of animal

substances, that had undergone extreme decomposition, into atmospheres containing ozone, and observed the rapidity with which the products of decomposition were neutralised and rendered harmless. I employed ozone medicinally by having it inhaled by persons who were suffering from fœtor of the breath, and with remarkable success, and I began to employ it, and have employed it ever since (viz., since 37 years), for purposes of disinfection and dissociation in close rooms, closets and the like.

"I should have used it much more largely but for one circumstance, viz., the almost impracticable difficulty of making it with sufficient ease, and in sufficient quantities to meet the necessities of sanitary practice.

"We are often obstructed in this way. We know of something exceedingly useful, but we cannot utilise it. This was the case with ozone. I hope that difficulty will be overcome."

1890.—Hatschek's apparatus is a mechanical arrangement for distributing the purified or ozonised air for floor maltings, tun rooms, but he does not describe any process for producing ozone; he merely says that the ozonising of the air can be effected by electric currents or otherwise, either while entering or leaving the apparatus.

——*Le Journal des Fabricants de sucre* describes the Rander process for refining and bleaching sugar by electric ozone.

——Fahrig patents, in Germany, a new ozoniser based on the principle of the condenser, and the plates of which, instead of being corrugated, as in his first apparatus, are stamped in such a manner that some blunt cones are formed, which slightly protrude.

Prof. G. Tolomei experiments with electricity on fresh milk in three different ways :—

1. By passing the discharge of a Holtz machine between two balls of platinum, inserted nearly 2 inches apart, in a bottle containing milk.

2. By sending a battery current between two strips of platinum at the bottom of a U-tube holding milk.

3. By sending a battery current through a silk-covered wire wound spirally round the test tube containing the milk.

In each case the acidulation was *delayed*, not *hastened*. Three equal portions of milk from the same milking began to grow acid on the 7th, the 9th, and the 6th day, respectively, whilst milk not treated with electricity was manifestly acid on the third day. The electrified milk (not the milk that has been heated to a high temperature and then cooled) coagulates naturally, or by action of rennet just like ordinary milk. Having thus seen that electricity could not be the direct cause of acidification of milk, Tolomei next tried the effect of ozone, and found it distinctly acidifying. In one case, the surface of a quantity of milk was brought close under the two bulbs of a Holtz machine, and the milk soon became acid in consequence, the sooner if the discharge was silent (not explosive), in which case more ozone was formed.

In another case, ozonised oxygen was used, to bubble through a quantity of milk which, in a few hours, was completely acid, and coagulated afterwards.

Prof. Tolomei is of opinion that oxygen also probably promotes lactic fermentation (a point which has been disputed).

——Lawson's ozone generator contains a number of glass or other insulating plates, parallel one to the other, varnished and coated on their upper side with tin or metallic foil, which is perforated so as to allow any air underneath it to escape when the plates are heated by the current, and to roughen the surface and facilitate the discharge.

1891.—A. Schnaller and W. J. Wisse describe their ozoniser, which consists of conductors of electricity enclosed in glass tubes, and alternately charged positively and negatively. These tubes are disposed on frames in an air-tight chamber.

——Dittrich, of New York, makes ozone water for medicinal purposes which retains ozone for an indefinite length of time, by adding to the ozone water a phosphite or hypo-phosphite, instead of chlorine compounds, such as hydrochloric acid, chloride of sodium, or other chlorides.

The characteristic of Mondouis and Socquart's ozoniser is the use of grids, and especially metallic sieves or gauzes, between which are disposed strips or cuttings of metal, the whole being placed in a glass tube. The internal tube is lined with a metallic grid or gauze; terminals connect the apparatus with the source of electricity, and the sides of the external and internal tubes are slightly separated from the metallic parts.

Bouillot, a French pharmaceutical chemist, ascertains that oils for medical purposes are better purified by ozone than by any chemical means, and he refutes the assertion made by some chemists that ozone is not active in the dark. He recommends inhalations of ozone in several cases, such as asphyxy, resulting from absorption of toxic reducing gases, asphyxic congestion, and infectious diseases caused by the volatile alkaloids known as toxines.

——Talbot patents a process for producing tartaric acid by means of ozone; his principle is that ozone transforms saccharine substances into intermediary acids, such as hexepic, tryemic, saccharic and glucosric acids, which, when exposed in the air, are changed into non-active dextro and lœvo tartaric acid, and into paratartric acid.

——Siemens Brothers state that the ozonisers up to the present consist in interposing between two conducting coatings charged with electricity of opposite sign, one or two dielectric layers, and the layer of gas to be ozonised.

To obviate this defect, they adopt an arrangement whereby both the electric coatings are situated outside on the same side of the dielectric layers.

The dielectrics are not only glass and mica, but all other insulating bodies, porcelain, earthenware, papier maché, gutta-percha, celluloid, caoutchouc, paraffin.

The characteristic features of their tube are, that :—

1. The conducting surfaces, separated by an insulating shield on one and the same side of the dielectric layer, are combined with an insulated conducting body on the other side of the dielectric layer, so that the silent discharges are effected all across a space through which the gas to be ozonised flows.

2. The apparatus consists of two dielectric jackets, each having a conductive covering, and secured together in a separable manner by insulating rings, within which jackets is an insulated metal tube, so arranged that between this and the dielectric layer an annular space is formed through which the gas to be treated flows, while a current of cooling liquid circulates through the interior of the metal tube.

——Pamphlet by Villon, showing the application of ozone to different industries, such as distilling, brewing, bleaching, tanning, ageing wines, chemicals manufacturing, varnish making, &c.

——Paper read at Berlin by Dr. Fröhlich, on experiments on ozone made at the Siemens works, and on the properties of ozone and its application to above-named industries. He says that in metallurgy the future of ozone is immense, but its importance is most prominent in industries such as the bleaching of paper pulp, fibres, yarns, tissues, wool, and other animal substances.

The following passage deserves to be added to Darwin's book on worms :—The action of ozone on insects is undeniable, but the quantity necessary to kill them is beyond the power of production. It acts even on the living organisms of the earth. If there are some worms in a pot where a flower has been planted, you can easily compel them to leave at once the pot, or, at least, to come to the surface, where they can be caught. They do not like ozone, and if, by means of a tube, you force some of it in the earth, they will emerge immediately, and try to escape the poisonous influence of ozone.

——*Mémoire* of Drs. Labbé and Oudin at the Académie des Sciences, refuting the error that ozone is a dangerous gas to breathe. They demonstrate the properties of ozone for killing germs and stop fermentations. Their researches with Mr. Veillon on the culture of bacilli on peptonised gelatine, and on the transport of the metals of the electrodes by the current. Their experiments on the volatilisation of the aluminium armature of their tubes at 8,000 volts.

1892.—Grumbacher patents in America an ozone machine for theatres, &c., which, apparently, is very complicated, but which consists really and merely of ordinary Siemens tubes, and of an induction coil. Nothing more ridiculous than those American patents, in the claims of which are enumerated, as in the present case, the *secondary circuit* of an induction coil, a *primary circuit* for the induction coil, a *commutator* or *circuit breaker* for said primary circuit, an *electric motor* for moving it, a *blower* for forcing air into the receptacle, a *drying chamber* for drying the air, an *interrupter* for the primary circuit, consisting of plates or blocks connected in pairs, and a receptacle in which ozone may be generated, and containing an *essential oil*, or similar material, through which the ozone generated is passed (*and must therefore be destroyed at once*).

——Guénet exhibits at the Société de Physique of Paris his tube (25 millimetres in diameter), containing three glass tubes 8 millimetres diameter, round which is wound an aluminium thread, 1 metre 60 long. Each tube contains an aluminium wire, 3 millimetres diameter and 150 millimetres long. This ozoniser takes 4 volts and 5 ampères.

——Experiments at the Faculté des Sciences of Paris by Troost, on the three forms of electric discharge, the effluvium which condenses ozone, but does not cause hydrogen or oxygen to combine, the *pluie de feu* which combines them slowly, and the spark which combines them instantaneously.

——See in the *Lumière Electrique* the description by A. Rigaud of the Jennings and Ducretet ozoniser worked by aid of a Carré or Wimshurst machine.

Korda says that the tubular ozonisers are only good for laboratory experiments, and that plane condensers of large surface are not economical and do not permit of continuous cooling of each layer of oxygen, an indispensable condition for obtaining a large output of ozone.

He constructs an apparatus, consisting of a bundle of glass tubes coated with silver inside, or of copper tubes tinned or nickelled outside. The interbular spaces form as many elements, surrounded by tubes containing a tube or glass ring which concentrates the discharge The tubes are connected in a special manner to an alternate current dynamo.

——Dr. Girerd. His glass tube ozoniser containing alumimium foil. He publishes some pamphlets, and the newspaper *Ozone*, to recommend ozonisation and ozonised remedies.

——Another paper, *La Médecine Nouvelle*, advocates ozone as a therapeutic agent. Ozone seems the *remède à la mode* in France. Ozonising apparatuses are installed in several French hospitals; and in May, 1892, at Lariboisière Hospital, the wounds of the victims of the dynamite explosion at Véry's restaurant are bathed with ozonised water.

Messrs. Allen and Hanburys, of London, exhibit at the meeting of the British Medical Association, at Nottingham, several models of a new ozoniser which, instead of being tubular, is open, in the shape of a music stand, or of a lantern, or of a double point bearing plate, opposite an enamelled metal electrode, the ozone diffusing through the rooms without any mechanical means for producing a draught.

E. A.

A CONTRIBUTION TO THE THEORY OF THE TELEPHONE.

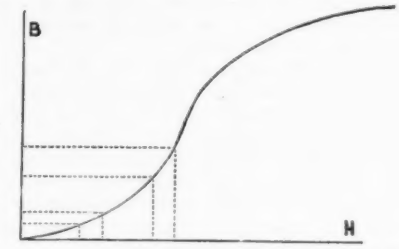
IN the development of the Bell receiver, it was found in practice that a louder effect could be obtained by employing a magnetised core instead of a plain soft iron core. This appears to be at variance with ordinary experience, it being generally supposed that for a maximum effect, the core in electro-magnets should be of soft iron.

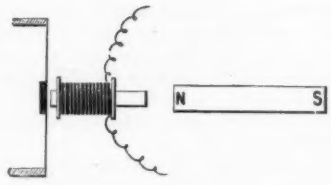
An explanation of this, which seems to be commonly received, attributes the improved results to the diaphragm of the receiver being kept permanently in a taut condition, and being thus, for some reason, in a better condition for taking up the vibrations than when left relaxed. However, no very clear ideas upon the subject seem to be current.

For some time past Dr. F. T. Trouton has been experimenting, with the object of clearing up this point, the result of which is to almost entirely refer the improved effect, obtainable by permanently magnetising the core of the telephone, to the fact that the mechanical force on the diaphragm, or armature of the electro-magnet, is proportional to the square of the magnetic force. He points out that the variations in the force on the diaphragm, and consequently its amplitude of vibration, will depend on the permanent magnetisation, as well as on its variation produced by the currents passed through the telephone. Or to look at it another way, it is important that, initially, the armature have strong magnetic poles ready to be acted on by this variation. (This would suggest magnetised steel diaphragms for louder effects.)

Another advantageous result arising from permanently magnetising a soft iron core by the addition of a steel magnet, as in a common arrangement of the telephone, probably is that the permeability of the soft iron is increased thereby; so that the magnetic force at the armature, arising from the current, is greater than were the current to act on an initially unmagnetised core. This effect probably is always unimportant compared with the last.

The effect here alluded to may perhaps be better understood by reference to the well-known curves of magnetisation (fig. 1), where it will be seen at once that equal small





variations in the magnetic force produce effects in the magnetisation dependent in amount on the initial position on the curve.

An apparatus which Dr. Trouton found convenient in his investigation is shown in fig. 2. It consisted of an ordinary tambourine, armed at the centre with a little piece of iron, which thus could be made to vibrate by an alternating current passed through an electro-magnet with a soft iron core, placed "telephone-wise," close up to the little piece of iron. The core could be permanently magnetised to the extent desired, either by a current passed through an additional coil wound on for the purpose, or by bringing up in line with the core a permanent magnet to a variable distance.

With such an apparatus it is easy to show the gain in sound brought about by permanently magnetising the core of the electro-magnet. For this purpose, an alternating current is employed of insufficient intensity to affect the diaphragm much; one then brings up the permanent magnet to the position shown in the figure, upon which the sound is found to be immensely improved. A similar result, of course, can be obtained by a permanent current sent round the additional coil.

To distinguish between the parts of this improved effect due, respectively, to the two causes mentioned above, one can either connect up the additional coil wound on the electro-magnet with an electro-dynamometer or with a telephone. If the improved action on bringing up the steel magnet were entirely due to the second cause (namely, the fact that then the same current is able to produce more lines of force in the iron than before), the deflection of the dynamometer, or the sound in the telephone, would increase in like proportion with the loudness of the tambourine. The experiment proves that though there is undoubtedly a slight increase in the number of lines of force, shown by a slight increase in the deflection of the dynamometer, the chief improvement is to be referred to the other cause.

Dr. Trouton made a similar experiment with the additional coil wound on the armature instead of on the core. This was effected by taking a rather thicker piece of iron than that which had been previously employed for the arming of the diaphragm of the tambourine. In connecting up a telephone with the coil, it could be arranged so as to have the sound from the telephone and from the tambourine, with the steel magnet removed, of equal intensity; then, on bringing up the magnet as before, the sound of the tambourine is found to be far and away louder than the telephone.

Lest it might be thought that the increased effect could be

due to the diaphragm coming nearer to the electro-magnet, in consequence of the attraction arising from the permanent magnet, it may be mentioned that similar effects are produced on placing the magnet on the opposite side to that shown in the diagram. In this position, the diaphragm lies between the magnet and the electro-magnet, and consequently tends to be drawn *further* away from the electro-magnet.

Dr. Trouton says that a somewhat curious effect is to be observed with this apparatus on employing an intermittent current instead of an alternating one. With an alternating current a continuous increase in sound is, of course, produced indifferently by either pole of the permanent magnet, as it is brought up from a distance to the position of contact with the core. Not so with an intermittent current. One pole effects, as before, a continuous increase in the intensity of the sound as it is brought up from a distance to the position of contact with the core; but the other pole, at first, as it is brought up, steadily *diminishes* what small amount of sound the current alone may be capable of producing: reaching a minimum, the sound again begins to increase, and continues doing so until the position of contact is arrived at. In this case the permanent magnet is opposed (that is, lies in the opposite direction) to the magnetisation produced in the soft iron by the intermittent current. The position of minimum sound evidently is that in which the average permanent magnetisation resulting from the intermittent current is just neutralised by the permanent magnet. For, as we have seen already, a small change in the magnetising force applied to an electro-magnet should produce least mechanical force on the armature under such circumstances.

In the current issue of the *Philosophical Magazine*, Dr. Trouton deals with this subject under the title "The Theory of the use of a Permanently Magnetised Core in the Telephone." Although we have made a very full abstract of this paper, our readers will find much more that is interesting in the original. Towards the end of it is an account of some rough experiments made by Dr. Trouton to obtain quantitative results, and those obtained agree with the theory as well as could be expected.

THE SUPPLY OF ELECTRICITY IN DUBLIN.

ABOUT a year ago the Dublin Corporation determined, after much discussion, to supply the city with electric light. Tenders were invited, that of the Electrical Engineering Company of Ireland being eventually accepted. Arrangements had been previously made by this company, with Messrs. Hammond & Co., to carry out the work, and the construction was at once proceeded with. Although the work was not finished as soon as expected, much progress was made, and now the central station has been practically handed over to the Corporation.

The electric light station is a large three-storey building situated in Fleet Street, at the rear of the old Parliament Houses. There is a good deal of similarity between this station and the model station of the London House-to-House Company. To say this is a guarantee of the good methods adopted in Dublin.

THE PRIVATE LIGHTING PLANT.

Our full page illustration shows the engine room in which are the Lowrie-Hall high tension alternating current system, which supply current to consumers' houses, the smaller picture showing the continuous current Brush system for lighting the street arc lamps. The private lighting plant consists of three pairs of compound horizontal non-condensing engines of 280 horse-power each, coupled to the Lowrie-Parker dynamos. These engines, which are made by Messrs. Coates and Company, of Belfast, work at a pressure of 140 lbs. per square inch on the valve boxes and run at a speed of 85 revolutions per minute. High and low pressure cylinders are fitted to each engine, the admission and exhaust of the steam being regulated by Corliss valves. The fly-wheels, weighing nearly 10 tons each, are 14 feet in diameter, and are grooved for twelve 1½ inch cotton ropes for driving the dynamos.

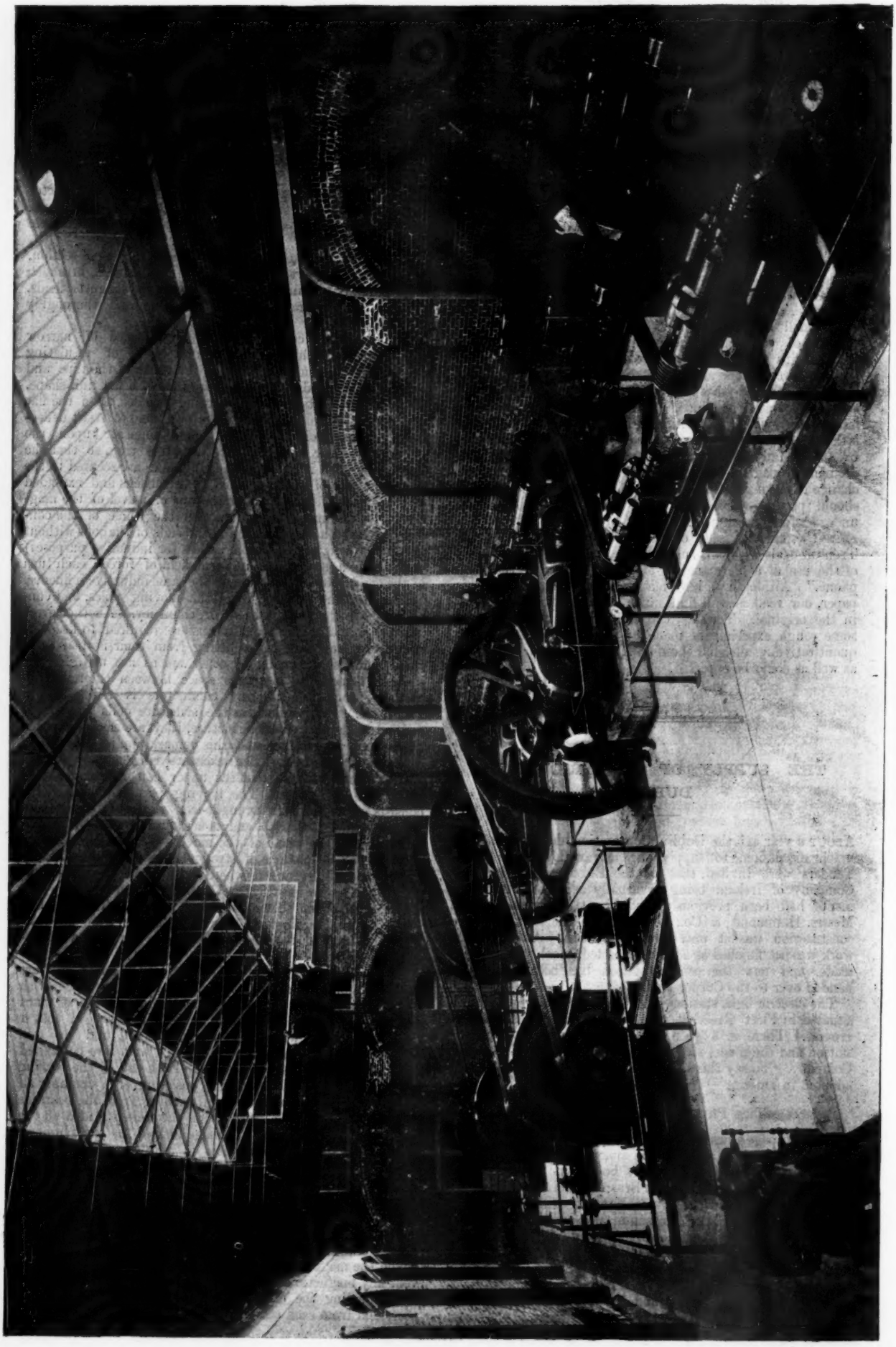
There are two main ranges of steam pipes and one range of exhaust piping, the latter running from the low pressure cylinders of the engines to the feed water heaters which are erected at one end of the boiler house. The engine foundations are built of concrete and granite blocks from the depth of 16 feet where the solid rock was reached.

Each of the three alternators gives an output of 75 ampères at 2,000 volts. Their speed is 350 revolutions per minute. The mean speed at which the armature conductor is passed by the field magnets is about 6,000 feet per minute, and the number of alternations 10,000 or 5,000 complete phases per minute.

The armature is stationary, with iron core of large section, composed of the very best charcoal iron sheets, arranged longitudinally and in the same plane with the magnetic fields, clamped to the frame of the machine and thoroughly insulated.

The armature conductor coils are formed of narrow copper tape, each wound upon a piece of insulating material of the same thickness as the width of the tape and rounded at the ends. The coils are thus of a flat link shape, the edges of the tape windings being exposed upon the flat surfaces of the coils, and therefore well able to resist deflection. These coils are placed close together upon the cylindrical inner surface of the armature ring, so that the axis of each coil is radial to the ring, and are secured to the same by strips of woods screwed to the cheeks and extended over the ends of coils outside the line of travel of the magnets. By this mode of construction the whole of the conductor (except a small portion at the ends of the coils without the line of field, and therefore useless for inductive purposes) is placed in a strong and uniform field of force; each turn of the conductor is under exactly the same inductive influence, and at the same distance from the moving poles, and consequently in the best position for efficiency. Another great advantage is that no special means are required to keep the conductors from sagging or lifting from their normal position; and as no wiring or other means are used for the purpose named, the clearance space between the revolving magnets and the standing conductors is reduced to a minimum. Furthermore, as the armature coils are simply secured to the face of the armature, they are easily removed or replaced as required, and this remark applies likewise to the magnet windings. The armature ring is parted upon the horizontal line, so that the upper half is removable for inspection or repairs. The moving part of the machine consists of a solid soft wrought-iron ring with pole pieces securely attached thereto, and is arranged so that the centrifugal force of the whole of the moving parts is taken by the ring. The base-plate is of strong box pattern, and strongly ribbed and underflanged where it bears on the slide rails. The frame for supporting the laminated iron armature core is cast separate and bolted to planed facings. The plummer blocks for the bearings are also cast separate from the base-plate and secured thereto by bolts and lugs and wrought-iron wedge keys.

The bearings are two in number, 20 inches long; they are in halves, jointed on the horizontal centre and fitted with loose brasses top and bottom. These brasses are of hard phosphor bronze. The bottom brass is so arranged that it can be removed without lifting the shaft, and yet well secured sideways; each bearing is fitted with two combined syphon and sight-feed lubricators. Each end of the bearing is provided with oil catchers, consisting of a chamber all round the shaft, by which the oil passing from the bearings is caught when thrown from the oil throwers provided on the shaft, and conducted by a passage formed in the plummer block under the brass to a waste oil tank or receiver formed in the plummer block or the base plate. The shaft is of best mild steel, 6 inches in diameter, the side thrust being taken by collars, forged solid on the shaft at each side of one bearing only; double grooves are cut for throwing the oil into the collectors at each end of the main bearings. Mounted on this shaft is a hub of cast-iron, attached to the ring on which the magnets are mounted in such a manner as to prevent any magnetic short circuiting. The rings on the shaft for collecting the exciting current are insulated from the shaft and from each other by ebonite washers. The brushes



GENERAL VIEW OF ENGINE AND DYNAMO ROOM.

and holders are supported from the base plate, and do not interfere with the bearings or plummer block ; each ring is provided with two sets of brushes, each set being ample for collecting the maximum current ; contact is kept by adjustable springs and each brush is separately provided with a safe and easy means of lifting and keeping it away from the ring while the dynamo is in motion. Fixed to the dynamo is a pulley of suitable diameter for driving the exciter, turned with grooves for four ¾-inch ropes.

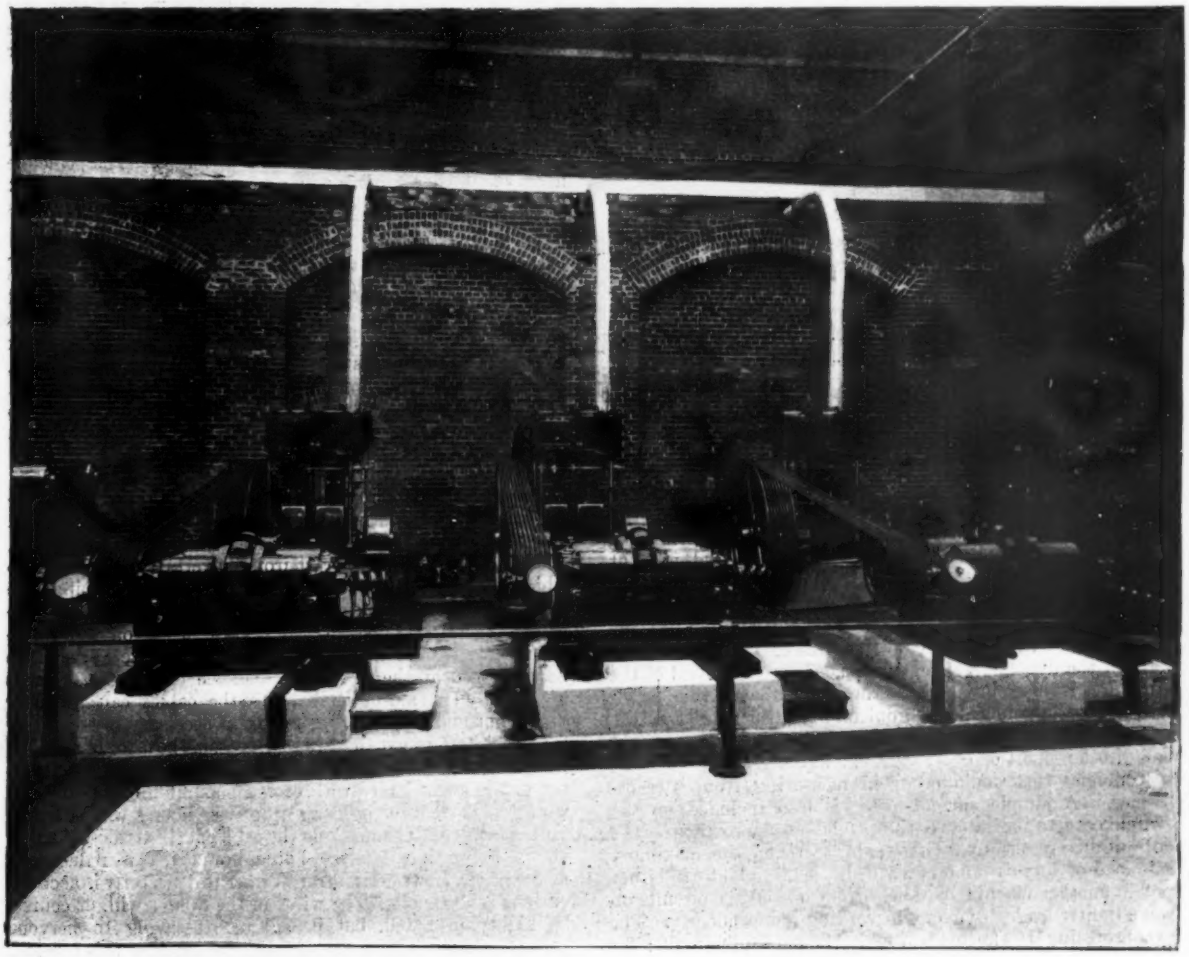
The exciter is a series-wound machine, with drum armature ; speed 800 revolutions per minute. The commutator is of ample size, and is stated to be entirely free from sparking, and provided with two sets of brushes and holders, each set of brushes being ample for collecting the maximum current, contact being kept by adjustable springs, and each brush is separately provided with a safe and easy means, when necessary, of lifting and keeping it away from the commutator, while the machine is in motion ; the lubricating and oil catching arrangements are similar to those of the alternating dynamo. Efficient means for tightening the driving ropes are provided, consisting of two cast-iron rails of heavy section, fitted at one end of each with forcing screws, provided with holding-down bolts for the dynamo, the nuts of which are of rectangular form and sliding in grooves formed in the rails ; the bolts being thus applied from above are removable without lifting the dynamo. The two rails are securely tied together with cast-iron distance pieces. Similar arrangements are supplied for the exciter.

The approximate weight of dynamo, rails, and exciter is 12 tons. The foundations of dynamos below ground are all built of concrete from the depth of 15 feet 6 inches.

The Street Lighting Plant.

At the opposite end of the room are situated the three sets of arc lighting plant comprising three vertical compound engines and three continuous current Brush dynamos. The engines are 60 horse-power and run at a speed of 220 revolutions per minute. There are high and low pressure cylinders, the low pressure being fitted with automatic relief valves. The fly-wheels are 8 feet in diameter and grooved for eight cotton ropes, thus coupling the engines direct with the dynamos. These are of the well-known Brush type, giving an output of 10 ampères at 3,000 volts. The speed of the dynamos is 800 revolutions per minute, and each machine is fitted on sliding rails for tightening the ropes. The armatures are of laminated iron wound with coils in 12 recesses, the opposite coils being connected in series, the free ends being brought out through the shaft, which is hollow, to the plates of the commutator.

A large travelling crane, capable of lifting 10 tons, is erected in the engine room and is used for moving and erecting the heavy portions of the machinery.



General View of Engine and Dynamo Room.

Arc Plant.

Boiler House.

The steam-generating plant is comprised of four of the Babcock and Wilcox type of water-tube boilers, each capable of evaporating 8,500 lbs. of water per hour at a pressure of 150 lbs. per square inch. The total heating surface in each boiler is 51 square feet. They are set in two batteries of two boilers each ; each battery being provided with a steam receiver, having outlets for the connections to the main ranges of steam pipes. Each boiler is composed of 14 sections or slabs, each section being composed of eight best lap-welded wrought-iron tubes 4 inches in diameter and 18 feet long, connected at the ends by continuous staggered headers or "up takes" and "down takes," the tubes being fastened therein by being expanded into tapered holes. The several sections are connected at each end to two steam and

water drums, and at one end with a mud drum, by means of lap-welded wrought-iron tubes 4 inches in diameter and of suitable length, expanded into bored holes. The steam and water drums are 36 inches in diameter and 33 feet 7 inches long, made of steel $\frac{3}{8}$-inch thick, and have longitudinal seams double rivetted and provided with a manhole at one end and two nozzles, one for a safety valve and one for taking off steam, 5 inches diameter, with 11-inch flange, faced and drilled. Each boiler is fitted with two safety valves of 5 inches diameter set to blow at 155 lbs., and there is a steam pressure gauge in front which indicates the amount of pressure of the steam in the boiler.

In close proximity to the boilers are erected three Worthington steam pumps, each capable of supplying water to two of these boilers when fully loaded. There is also all the requisite wrought-iron piping for the connections between the pumps, boilers and water tanks, the latter being erected in front of the boilers over the coal bunkers. Close to the large chimney shaft are the three feed-water heaters, each heating a sufficient quantity of water to feed two of the boilers. They are connected with the main exhaust steam pipe, and are fitted with by-passes and a complete arrangement of stop valves to enable the exhaust steam from the engine to be sent through any of the feed-water heaters, or past them. The exhaust pipes are carried from the heaters up the chimney to within a few feet from the top.

OFFICES AND TEST ROOMS.

At the east end of the buildings are commodious offices and switch and test rooms. The switch room, in which all the electrical connections converge, is fitted with a very complete set of instruments for controlling the current and regulating its distribution between the several circuits. The three Lowrie-Parker alternating current dynamos (of 150 kilowatts) are connected by separate leads with the private lighting switchboard, so that any one of them can be run on either of the two mains. The arrangements also permit of the machines being run in parallel, and a special synchronising board is provided for this purpose.

It may be interesting to give here a few particulars of this method of running the alternators. The mains from the alternators are first brought to safety fuses in the switchboard, arranged so that a fuse can be instantly replaced without stopping the dynamo; and by a system of four break switches any dynamo can be put in communication with any circuit or circuits, or the whole of the dynamos be put in parallel circuit. Besides these mains conveying the entire electromotive force of the dynamo, a small wire placed across one coil of the armature is also brought to the switchroom; this is for measuring the voltage, synchronising, and for regulating the pressure. Each coil being similar, the measure of one coil is a direct proportion of the whole, and entirely prevents any inaccuracies that would occur in measuring from a transformer. A simple current-meter is also included on the switchboard to indicate to the attendant approximately the current given out by each dynamo. When the maximum safe load of any dynamo is reached, the attendant can either put in another machine parallel or put one of the circuits on some lighter loaded dynamo, if working independently. The synchronising is effected through the one-coil circuit; for instance, if one machine shows by the indicator that the load is approaching the normal, and another plant is started, a small switch places the second machine parallel with the first machine, though one lamp only be placed on the synchronising board. When the phases of the two dynamos correspond, the lamp is steady and bright, but not until then. The second machine is then instantly put in parallel with the first by the insertion of one main switch, and at once takes half the load. The slightest inclination of one plant to get out of pulse with the other throws the majority of the work on the faster engine, and reduces its speed, so that one plant entirely controls the other. The regulation is also done from the single coil current, a small converter being interposed between it and the regulator to insure the attendant from any shocks that might accrue from a fault on the circuits or dynamo. It is a very simple, inexpensive piece of machinery, only having to convert a low tension to another about equal.

A complete set of voltmeters and ammeters are provided, the former being of the well known Cardew type.

A hand regulator in the form of a variable resistance is placed in the exciter circuits for keeping the voltage constant between the mains. The latter, however, will not, as a rule, be needed, as three of the Lowrie-Hall patent automatic regulators have been put in connection with the machines. The principle is that of a shunt of varying resistance on the magnet of the exciter. A special feature of the arrangement is found in the main switches; these are made in the shape of four copper plugs attached to a massive block of insulating material with a handle at the back. The plugs fit into porcelain sockets containing brass tubes in connection with the mains, accurately tapered to receive them, and attached to the heavy slate base of the board. A long break is thus made on both poles of the circuit on drawing out the plug-handle, and forms a very efficient double-pole switch. The same form of switch is also used in the arc lighting, for bringing the dynamos in connection with the three circuits into which the streets are divided. Similar porcelain sockets are also made use of not only for the switch-plugs, but also for smaller plugs, to which flexible leads are attached in such a manner that any dynamo can be run on any circuit, or, if need be, two or three of the circuits can be put in series by simply changing their positions in the sockets.

Automatic regulators of the Brush-Geipel type are put in conjunction with each of the arc lighting machines, and serve to maintain a very constant current in the mains, and therefore very little flickering of the lamps. The principle upon which they work is a shunt on the field magnet circuit of the machines, the excitation of which is modified so as always to maintain the most suitable current in the lamps.

All the instruments for both public and private lighting, with the exception of the automatic regulators, are fixed to the large polished slate bases mentioned above, supported by a strong wooden framework which forms two sides of the room. Between this framework and the brick wall of the building, is a passage of about three feet wide, with a trench containing the cables running to the street and dynamos, and from these all the necessary connections to the instruments are made and can always be readily inspected.

THE SYSTEM OF MAINS.

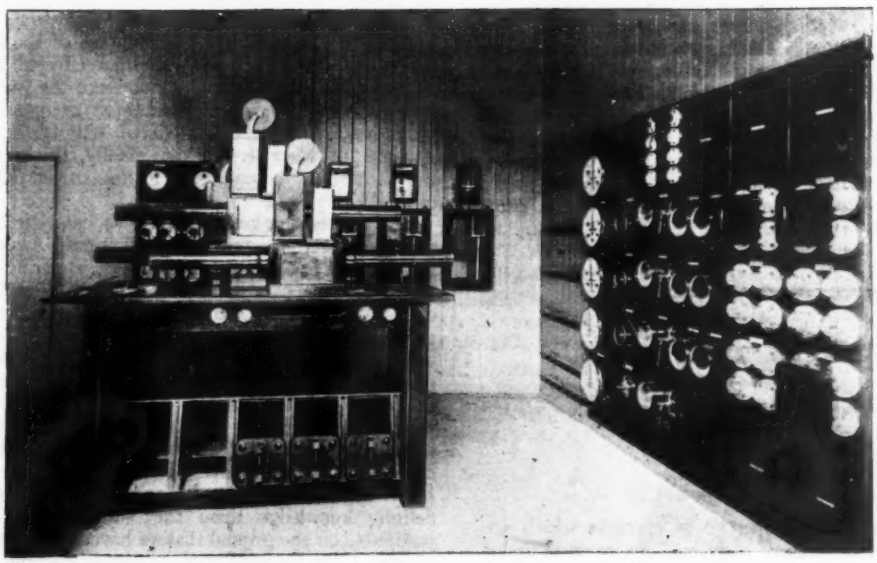
The system of mains for distributing the current in connection with the station is that of the Lowrie-Hall patent. The mains are laid underground, chiefly below the pavements, and consist of lines of cast iron culverts and boxes, into which the cables are drawn. Various sizes of pipes are used, from 3 inches to 6 inches in diameter, while the patent Lowrie-Hall surface boxes are made on the interchangeable system and are suited to any size pipe, these being placed in the street at a distance of about 70 yards apart. By the aid of these boxes the cables can be easily drawn out and inspected for repairs if necessary, without any further interference to the street, from box to box. The pressure on the mains which will convey the electricity to the public street lamps will reach a maximum of 3,000 volts, while the current for lighting up private houses will be transmitted from the dynamo along the cables at the tension of 2,000 volts. Before it enters the house, however, it is reduced by means of the Lowrie-Hall transformer to a perfectly innocuous current of 100 volts. The wires in the houses will, of course, be highly insulated, but it will be reassuring to nervous persons to know that a contact with a current of this tension, though perhaps it would give a slight shock, is quite harmless, and would endanger neither life nor limb.

The transformers used are the Lowrie-Hall patent, and are specially made by the Leeds and London Electrical Engineering Company, Limited, while the meters, which will register the amount of current used by the consumers, are of the Schallenberger type.

At present only the following streets will be lighted by electricity:—Grafton Street, College Green, Dame Street, Parliament Street, Capel Street, Mary Street, Henry Street, Sackville Street, D'Olier Street, College Street, and Westmoreland Street. In these streets are erected 78 lamp posts, reaching to the height of about 23 feet. The lamps themselves are the Brockie-Pell, recognised for their steadiness and reliability. The light given equals about 2,000 candle-power. The testing apparatus consist of a Wheatstone Bridge in conjunction with a highly sensitive galvanometer of the Sir William Thomson type, with the usual complement of shunts, a massive reversing key, and a large battery of Leclanché cells, giving about 115 volts pressure. Most of the instruments in regular use are

attached to a table in the test room, of special design, with the connections marked upon the top. The galvanometer stands upon a granite column sunk some 12 feet into the ground to the surface of a hard gravel stratum, the object being to protect the instrument from any vibration, which would necessarily interfere with its readings. A complete set of apparatus for re-standardising any of the instruments used in the station is also provided, in the shape of a standard current balance, an electrostatic voltmeter and rheostat resistance, all of the Sir William Thomson pattern. If necessary, the house meters can also be readily tested and re-calibrated by means of these instruments. Altogether, the testing rooms are fully equipped with the latest patterns of instruments connected with the science of electric light supply.

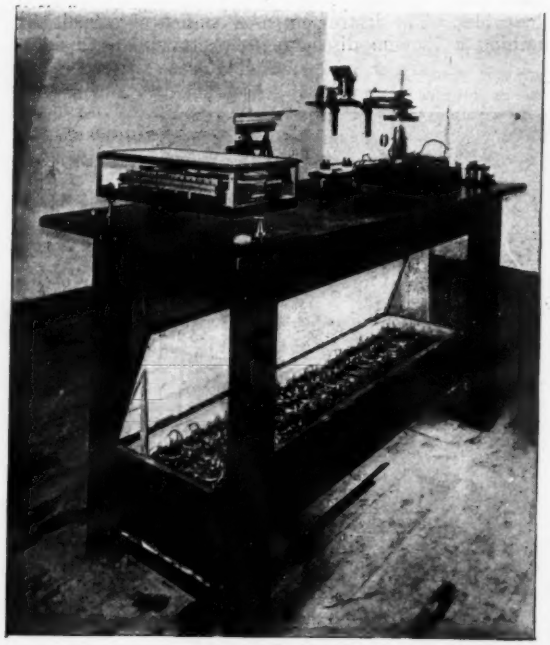
BOILER HOUSE.



SWITCH AND REGULATING APPARATUS.

The generally adopted method of testing the insulation of the mains is to take a circuit when the current can be conveniently stopped each day, and then test for insulation with the Thomson deflecting galvanometer and Wheatstone bridge. This in a continuous supply, was known to be defective, so a novel and simple instrument has been devised that shows at a glance and, if necessary, records any change of insulation in the cables. The instrument used consists of a small box containing a vacuum discharge tube provided with sight-holes. One terminal of the tube is connected to earth, while the other is put to the cable which it is desired to test. If the insulation is good there is a glow in the tube due to the static charges in the conductor, but if there is any defect in the insulation this glow is diminished according to any earth connection which exists. Should any circuit get dangerously low in resistance to earth it is stopped at a convenient time, either night or day, and the fault localised and

removed in the ordinary manner. By the use of this continuous recorder, a defect can be remedied before it has gone so far as to cause a breakdown; and as all the underground work is very high class the risk of a defect arising is extremely small.



TESTING APPARATUS.

GENERAL.

The number of lamps in consumers' houses that can be supplied from the station (with one set of plant remaining as a reserve) is 10,000 8-C.P., and the number of lamps connected to mains can reach the total of 20,000. This is the alternating plant, of course.

The length of mains is as follows:—Incandescent, 8½ miles; arc 9½ miles.

The total cost of station, including everything, will amount to about £38,000. Cost of mains is about £6,000. Best Welsh steam coal, costs 19s. 6d. per ton.

The following will be about the required staff for running the plant at full load:—one manager, one electrician, one switch-room attendant. Incandescent plant will require—two drivers, two dynamo men, two cleaners, one fitter. Arc plant—one driver, one dynamo man, three lamp trimmers. Boilers—two men.

THE CURRENT THAT CURES.

BY H. NEWMAN LAWRENCE, M.I.E.E.

III.

(Concluded from page 331.)

AS already indicated, the properties of currents which are mainly of use upon the human body, may be grouped under two heads, viz., physical and physiological. By the former I mean those properties of currents which affect the body under the ordinary laws of inanimate conductors, and by the latter those properties of currents which influence the body as a living organism, and are over and above the former.

In Article II., I have referred to the great resistance of the body, except when by soakage of the skin, and a proper adjustment of contact area, the skin resistance be reduced to a minimum. Even when the total resistance has been so brought down, the conductivity of the parts is by no means uniform. Some are much better conductors than others, and the conductivity in some places differs with the direction in which the current traverses them.* All these points have their influence on the question of how the current cures. Superficial areas, deep structures, and specially protected organs have to be acted upon, and such action localised or diffused, according to the necessities of the case. Whatever the property of current relied upon, the action is to a large extent, if not wholly, proportional to the current density, so that great need exists for the careful selection of suitable sized electrodes, and the proper positions for them.

The therapeutic actions of currents are given by Erb† as electrolytic, cataphoric and catalytic, and are thus described by him. After defining the ordinary process of electrolysis illustrated by the electrolysis of water, he says: "Exactly similar phenomena occur also in animal fluids and tissues; as Dubois-Reymond, Hermann and others have shown, the electrolytic processes occur wherever a current passes from another conductor into an electrolyte, where two electrolytes are in opposition, and also in the interior of more solid masses which are permeated by an electrolyte and through which a current is flowing. The animal organism, when penetrated by an electrical current, presents such a condition; electrolytic processes may therefore develop within it."

"The other physical effect to which I wish to call attention, is the so called mechanical or cataphoric action of the electrical current. It is possibly of great importance in therapeutics, and depends upon the general fact that, during the passage of a current through an electrolyte, contained in porous bodies (such as clay, baked or not, animal and vegetable tissues, &c.), fluid is moved from the anode to the cathode, *i.e.*, in the direction of the current. The amount of fluid conveyed in the porous body, in a unit of time, is so much larger the stronger the current and the less the conducting power of the fluid. Firm particles, suspended in the fluid, are said to move in the opposite direction to the fluid itself. It is evident that the animal tissues are constructed in such a manner as to favour the production of these cataphoric effects."

Again, in speaking of catalytic actions, "under this heading Remak includes in the first place *the dilatation of the blood vessels and lymphatics* and the consequent impulse to the circulation produced by the passage of an electric current; the *increased power of absorption* conferred upon the tissues; the *promotion of osmotic processes*, and, as an effect of the two latter causes, the increase of tissue bulk, especially in muscles. With these may be enumerated the influence *upon molecular interchange and nutrition* effected by exciting or soothing the nerves directly or through the parts which they supply; changes in the *molecular arrangement* of vital structures, and in their nutritive activity, due to the phenomena of electrolysis; and finally, the consequences of the *mechanical transference of fluids* from one pole to the other."

The phenomena grouped above as catalytic actions are to some extent those previously mentioned separately, and it appears that Erb, or, at least, Remak, whom he quotes, makes use of the term catalytic to cover nearly all the properties of currents upon the body. Later writers think that such grouping of widely different actions is hardly consistent with scientific accuracy. Messrs. Liebig and Rohé,‡ in their excellent hand-book, say:—"The effects comprised under the cataphoric, vasomotor, and trophic effects, have been ascribed by R. Remak and others to *catalytic* action. This term, which did duty for so long in chemistry, until the advance of science rendered it superfluous, has been adopted by a number of electro-therapeutists to cover our lack of definite knowledge upon the subject. Its use is only justifiable on the ground that we have no well defined notions of what takes place when the galvanic current produces the effects spoken of. We may excuse ourselves for using the term . . . . . but its use is hardly creditable to our scientific honesty. It were better to drop it out of our technical terminology."

It seems to me that by whatever name we call them, that, with the exception of the cataphoric, most of the effects

* Paper by Author before British Association at Edinburgh, 1892, on "Human Body as a Conductor."

† "Electro-theraputics," by Dr. W. Erb.

‡ "Practical Electricity in Medicine and Surgery," by Drs. Liebig and Rohé.

grouped by Remak and Erb under the term catalytic are physiological rather than physical, due to the special conditions of living organism rather than to the ordinary physical properties of inanimate substances.

For those who care to study the action of electricity upon the body there is still a wide field to investigate, but I venture to submit that even our present incomplete knowledge enables us to give a reasonable indication of "how current cures."

In conclusion, let me summarise the position as follows :—

1. On the evidence of some of the greatest medical scientists, electricity is a most valuable curative agent in very many of the known diseases of man.

2. The opinion of these men has been formed, to a large extent, upon the results of empirical and loose methods of application.

3. Enough is now known of the measurement and control of electricity to render more accurate and reliable work easy. It is reasonable to expect that more accurate methods in electro-therapeutics would produce better results.

4. The bulk of the medical profession (in England, at least), only resort to electricity as a sort of forlorn hope, when other forms of treatment have failed.

5. As instruction in electro-therapeutics forms no part of their training, and they have little or no opportunity for taking it up afterwards, medical men are not in a position to make proper use of electricity themselves.

6. Those of them who do desire to employ it cannot, even if they have the necessary knowledge, spare the time required for the applications, and therefore entrust their patients to nurses and so-called medical electricians, who, with few exceptions, are not in any way competent to carry out electrical treatment.

7. In consequence of these circumstances, the medical profession have neglected to make fair use of electricity as a curative agent, and treat the subject with indifference.

8. Owing to this neglect and indifference of the legal trustees of the healing art, others, for the most part ignorant and unscrupulous, have sprung up, who, taking advantage of this and of the present popularity of all things electrical, prey upon the pockets of a credulous public by an utter misuse of the term "medical electricity."

These things being so, is not the matter ripe for serious attention at the hands of electricians as well as medical men? Cannot something be done to enable this valuable branch of applied electricity to receive its proper development in common with others? An effort was made about four years ago by establishing an Institute of Medical Electricity, which, though it received the countenance of most of the leading electricians, and a few medical men of high standing, was nipped in the bud by the Royal College of Physicians, and so boycotted by the influence of that body, that it came to an end a year or so ago, starved out by those who should have fed and fostered it.* Possibly, however, this scheme was misunderstood, and was so treated because it trod too roughly upon the corns of an ancient and eminently conservative corporation, rather than from any desire on the part of that body to stifle honest endeavours at scientific development. Doubtless there are other ways out of the difficulty. I venture to suggest one to which little objection could be taken from the medical side. Establish a school for medical electricians, somewhat after the style of the famous Ling Swedish Movement Institution at Stockholm, wherein, under a form of control, in which medical men should have considerable share, practical operators in medical electricity might be trained. The students so trained might occupy some such position as that of the chemists and druggists, duly authorised to carry out the instructions of physicians, but not permitted to prescribe. The training would extend over a reasonable period, say, two years, and would involve instruction in anatomy, physiology, electricity and electro-chemistry, together with the theory and practice of electro-therapeutics. The teachers might become a sort of central authority for the investigation and development of all that pertains to medical electricity, while if they could be authorised by the State to test, and, if necessary, condemn the various so-called "electrical appliances," a great additional boon would be conferred upon the community.

* See Article in *Truth*, July 22nd, 1892, "Electrifying the Royal College of Physicians."

NOTES.

Joined in Parallel.—The marriage of Prof. Arthur William Rücker, F.R.S., to Thereza Charlotte, youngest daughter of Prof. N. Story-Maskelyne, F.R.S., of Basset Down House, Swindon, took place on 7th inst., at Wroughton, Wiltshire.

City of London College.—The City of London College syllabus for the 45th session, 1892-1893, is now issued. The Michaelmas term commences on Monday, October 3rd. Intending members and students are respectfully requested to take out their tickets and class vouchers *before* Monday, October 3rd.

An Elevated Electrical Railway for Berlin.—A telegram from Berlin, in Tuesday's *Financial Times*, reads as follows:—"It is expected that a concession to construct an elevated railway in Berlin will be granted to Messrs. Siemens and Halske, the eminent electrical engineers. It is intended to commence operations immediately after the return of the Emperor from the autumn manœuvres."

Dr. Werner von Siemens.—Dr. Werner von Siemens has been staying recently at Harzburg, in the Harz Mountains, with a view to getting rid of the *sequelæ* of the severe attack of influenza from which he suffered last winter. He is reported to be making favourable progress towards recovery.

Effect of Lightning on Electric Wires in Spain.—During the recent thunderstorm at Aguilar, in Cordova, the lightning, besides rending the walls of two houses, fused about 50 metres of electric wire, forming part of the local electric light installation. The inhabitants, thinking the intensity of the storm was increased by the electric plant, cut down some of the cables belonging to the electric company.

Oxford Electric Lighting.—The Oxford City Council at their meeting last week adopted the recommendation of the General Purposes Committee to expend an amount not exceeding £210 per annum, on a three years' contract for lighting the central portions of the city with electric lamps of 1,200 candle-power, in accordance with the plan and specification to be arranged between the Electric Company and the city engineer.

Inspection of Cable Stations.—Sir John Pender, chairman of the Eastern Telegraph Company, and a party which included Viscount Wolseley, Sir James Fergusson, M.P., the Dean of Westminster, and Sir Robert Herbert, arrived at Plymouth at half-past six on Saturday evening, and were driven to the West Hoe Pier, whence they proceeded to the Eastern Telegraph Company's twin-screw steamer *Mirror*, which arrived in the Sound on the previous day. The vessel was brilliantly lighted by electricity as the distinguished voyagers boarded her. The *Mirror* left for Gibraltar, and will visit the various stations of the company during a cruise of several weeks. The visitors will return overland from Marseilles.

A New Magnetic Rock.—A green rock, strongy relsembling serpentine in appearance, has recently been discovered in large quantities at Borzanasca, in Liguria. The most curious feature about it is that it possesses distinct polar magnetism. The rock has been analysed, and found to consist of silica 39·84, alumina 3·08, iron oxides 7·07, magnesia 36·63, lime 1·14, water 12·86. The microscope reveals the presence of bastite and small crystals of diopside, diallage and chrysotile, but the magnetic properties are difficult to account for.

Copper.—The copper statistics, says *Money*, work out more satisfactorily than was expected. The visible supply in England and France, and afloat thereto at the end of August, was 59,718 tons, or 20 tons less than at the end of July. Twelve months ago the stock was 59,629 tons. The deliveries in England and France during August were 8,755 tons, against 8,499 tons in July. For the 12 months ending August, the deliveries were 109,666 tons, against 125,780 tons in the previous 12 months. The present price of copper is £8 per ton lower than it was a year ago.

Electric Lighting for Fleetwood.—A number of members of the Fleetwood Tradesmen's Association visited Morecambe last week for the purpose of obtaining information regarding electric lighting.

A Small Strike.—Practically the whole of the men employed in the fitters' department of the Edison and Swan Electric Light Company's factory at Ponders End are out on strike. Certain arrangements in the factory causing dissatisfaction among the *employés*, they held a meeting to discuss matters, and the following day it seems that for that reason two of the men were discharged, with the result that the whole of them (about 60) came out on strike.

Electric Lighting at Altrincham.—A conference of local authorities, including Altrincham and Bowden Local Boards, Altrincham Rural Sanitary Authorities, and the Knutsford Highway Board, was held at Altrincham on Tuesday evening to consider a proposition for supplying the electric light to houses, public buildings, and streets in their districts. The members expressed themselves generally in favour of the application of the Electric Lighting Company, and appointed a committee to consider details and report to a future meeting.

The Protection of Metallic Surfaces.—By producing a thin layer of magnetic oxide of iron upon articles of wrought or cast-iron, their surfaces may be preserved from atmospheric deterioration. This fact has been known for some time. Mons. P. H. Bertrand, however, has recently applied it as follows :—He coats the surface of the iron or steel by electro-deposition with some metal or alloy which is capable of being volatilised at a temperature of 1,000° C. The article, or portion of machine, for example, is then introduced into a furnace heated to the required temperature. The iron becomes oxidised, but only to the magnetic oxide stage, and the metallic coating volatilises, the operation being complete in a few minutes.

Interesting Results with Fuse Wires.—Some cuts appearing in the New York *Electrical Engineer* of fuse strips, made from two different alloys, show, in an interesting way, the difference in the manner of fusing. One figure shows a strip made from the metal in common use. Under the action of the heat a crust of oxide apparently forms on the surface, preventing the fuse from breaking at once, but causing it to run and bubble in the interior until the molten metal breaks through this outer skin. It will readily be seen that such a fuse will open the circuit awkwardly—scattering the hot metal and causing much arcing. The other figure shows a strip made from the special alloy used by the Shawmut Fuse Wire Company in their tested fuse wire. In this the fuse remains solid until a certain point is reached, when a part of the metal drops out bodily, making a quick and clean break of the circuit and thus preventing, to a large extent, the destructive effects on terminals and fuse blocks.

Badt's Alternating Current Electric Railway System.—This scheme, which we notice in an American exchange, does not seem to us to be new, but to be simply a modification of previous attempted solutions, and, like all of these, it breaks down through the want of a suitable self-starting non-synchronous motor, as well as from the complex arrangement involved. The idea is to lay a pair of high-tension mains in the ground between the metals, and at suitable intervals to also put transformers in the ground. The high-tension mains would pass through the bottom of the transformer and be connected to the primary circuit, the low-tension secondary coil being coupled to the rails. Switch devices are arranged to do away with the necessity of a transformer for every length of rail, which is, for reasons of economy and safety, limited to the car length. A local circuit is provided from a few accumulators on the car for closing the switch when the car is to start from rest. Further description is unnecessary ; our readers will see that, even if the motor were forthcoming, the complexity of the details would be probably sufficient to condemn the system, and certainly at the best a large amount of experimenting would be necessary before even a moderate success would be obtainable.

Provisional Order for Poplar.—The Poplar Board of Works, at their meeting last week, resolved to apply for a provisional order for lighting the Poplar district by electricity.

Waterford Electric Lighting.—We hear that Waterford inhabitants are protesting against the decision of their Town Council to abandon the use of the electric light for its streets.

Bradford County Council.—At the meeting of the Bradford County Council, held last Tuesday, the Gas and Electricity Supply Committee propose the acceptance of tenders for the extension of the electricity works in Bolton Road, at a cost of £2,745 9s. 4d., and the purchase of an additional main wire, 1,075 yards long, from Messrs. Siemens, at a cost of £828, for the extension of the Kirkgate service.

Electric Lighting in Leeds.—The company who have undertaken to supply Leeds with the electric light expect, within the next few days, to commence laying mains in the thoroughfares which it is proposed to light as a commencement. There seems to be no reason to doubt, says the *Leeds Mercury*, that the company will be in a position to supply electricity in November.

Visit to the Electric Belt Establishment.—The Oxford Street electric belt establishment has been visited by a representative of the *Pelican*, at Mr. Harness's invitation. It is only right, however, that in describing his visit, he should modestly own that his "knowledge of electricity is of a very shadowy character ;" but yet he is bold enough to say that he left the "colossal establishment with a very clear understanding as to the methods employed at the Electropathic Institute." "The apparatus," he says, "struck me as being very complete, and I can well understand that the surprising development of this most surprising establishment must have cost Mr. Harness years of constant labour, and the expenditure of thousands of pounds." The subject of the efficiency of the belts is judiciously avoided, therefore the visitor's task became very simple, because anyone can talk about buildings, furniture, commercial methods, &c., while the real point at issue is left alone.

Electric Search-Light in time of War.—On Saturday last, Colonel Tully, in temporary command of the 4th V.B. Surrey Regiment, organised some interesting night operations on Wimbledon Common, mainly with the object of giving his men an opportunity of manœuvring under the beams of an electric search-light. The scientific part of this display was provided by Captain Ronald Scott, 4th Middlesex Rifles, who demonstrated the facility with which an electric search-light may be used, even when the means of mounting it are of the most primitive kind. He had the projector mounted on an ordinary waggon, in which accumulators were placed and these were sufficient to give him illuminating power equal to 13,000 candles. When the attack began he was enabled to throw a broad light well over the heads of sentries, who by its aid could see every inch of ground far in front of them while remaining themselves concealed, except when by accident the ray was thrown behind them, revealing their exact position. That slight mishap, however, did not tell the enemy much that he would not have learnt a minute later in another way. As the sentries fell back upon their picquets the latter extended and opened fire by volleys that only intensified the gloom of a night so dark that nothing could be seen more than a few yards off, except where the electric light played. Having got that completely under control by this time the manipulator flashed it with much effect in the enemy's eyes, blinding them so that they could not possibly have taken aim, and at the same time showing them up very clearly for the defending riflemen to fire volleys at. From half-past seven until nearly nine the little fight in its various phases lasted, and during these 80 or 90 minutes the volunteers engaged had opportunities of learning many valuable lessons, by which they doubtless profited much, while some scores of spectators enjoyed a very novel and interesting spectacle. Towards the end, however, rain fell in such heavy showers that Colonel Tully brought these night operations to a somewhat premature termination. Captain Scott was ably assisted by three of his work's staff, Messrs. Swetenham, Roe, and Turrell.

Workhouse Electric Lighting.—At a meeting of the Oldham Board of Guardians last week, a committee was formed to consider the question of introducing electric lighting into the workhouse premises.

Electric Lighting of Dundee.—At a meeting of the Lighting Committee of the Dundee Police Commissioners last week, a sub-committee was appointed to consider and report as to the advisableness of lighting the leading thoroughfares in the centre of the city with electricity.

Taunton Electric Lighting Company. — Perhaps more difficulties are besetting the introducers of the electric light at Taunton, than at any similar town in the Kingdom. A numerously signed petition, objecting to the granting of the application of the Taunton Town Council (in which they ask to be empowered to erect and maintain works for the supply of electricity for lighting and other purposes in the Borough of Taunton), has been forwarded to the Board of Trade by a number of the ratepayers. These are their objections: 1. That it is the avowed intention of the Town Council to purchase the premises and plant of the Taunton Electric Lighting Company. 2. That an expert electrician having been engaged by the Town Council to advise them on this matter, did most emphatically declare against the purchase, and spoke of the system worked by the company as costly and inefficient, characterising the buildings, plant, and apparatus as unsuitable, and certain to be unprofitable. 3. That the purchase of the works and the cost of a partial extension of the same would amount to £14,000. The instalment of principal and the interest payable on this amount would be about £700 per annum for 30 years, while the estimated loss on the working would be, at least, £1,200 yearly, together making a dead charge on the rates of nearly £2,000 per annum. It will certainly be very interesting to see how matters are eventually decided, but at the moment the Town Council and the Electric Lighting Company seem to have some very unpleasant difficulties to encounter.

Magnetism and "Magnetism."— On the authority of Lord Bacon we have it that "truth is more easily evolved from error than from confusion;" hence the readers of *The English Mechanic*, who are undoubtedly an intelligent constituency, may yet have a glimmer of hope that some good may result from Mrs. Besant's series of articles on "Mesmerism and Hypnotism," which are appearing in that paper; in spite of the fact that "error" *and* "confusion" appear to be uniformly and liberally distributed. The second article, which was published on September 2nd, is quite as extraordinary a production as the first. Magnetism is still held to be synonymous with "magnetism." Terms not to be found in scientific glossaries and similar "prejudiced literature" are confidently tossed about. We learn that "magnetism is practised;" that "patients are magnetised;" that "fiery brushes of light" can issue "from the points of the fingers of healthy men," and that this phenomenon is analogous to the "magnetic polarity exhibited by crystals;" that there is "a subtle form of matter capable of being thrown into waves by magnetic energy, proceeding from ordinary magnets, from crystals, and from the human body, and manifesting itself as light," &c., &c. Mrs. Besant suggests that "this all-permeating and mobile substance, characterised by its susceptibility to wave-motion, and by its very nature the storehouse of all energies, is the akâsha of the occultist, the ether of the modern scientists, and, in its lower manifestations, the astral matter of the Theosophists." After this we can only wish that Mrs. Besant would herself, before she writes any more, pass into the "magnetic trance in which the patient becomes *lucid*." If only this daring lady would settle down, say, to ten years of experimental research, and then bring forward her results and the theories which she bases upon them, she might then be entitled to be considered seriously. As it is, well——. There is one great truth expressed in Mrs. Besant's article which she seems to lose sight of, although she starts with it, namely, that "nature does not alter her facts to suit academics, scientific or otherwise," neither, we might add, does she permit a theosophist, a hypnotist, an occultist, or any other abnormal development of the genus *homo* to distort her "facts" to suit their own purposes.

More about Electric Belts.—A very "highly coloured" description of the Electropathic Institute appears in *Hearth and Home*, from the pen of some individual writing under the appellation "Seeing is believing." We have not space to refer lengthily to the remarks, but when we see it stated that one of Mr. Harness's ordinary electric belts is capable of generating a current sufficient to ring an electric house bell, we must emphatically deny the possibility of such a thing. The representative of *Hearth and Home* was not aware that the bell might have been connected, through the medium of the belt, with another and more powerful battery, and that it was this, and not the electricity from the belt, *per se*, which rang the bell.

Charterhouse Science and Art Schools and Literary Institute.—The winter session of this, one of the largest science and art schools in the United Kingdom, will commence on Saturday, September 24th, under the presidency of the Rev. Henry Swann, M.A. During the late session upwards of 1,060 students, mostly elementary teachers, availed themselves of the privileges afforded by this Institution, and of this number nearly 700 presented themselves for examination and were successful in obtaining a large number of class certificates, and also a fair number of honours certificates awarded by the Science and Art Department of South Kensington. Several students prepared for the Lond. B.Sc. (Int.) examination, and highly distinguished themselves. Instruction of a practical character is given in most of the sciences at a very nominal fee; whilst in art at an equally low rate. Full particulars of the classes may be obtained from C. Smith, organising secretary.

The Best Light for Libraries. — Chemists have long ago decided that the products of the combustion of coal gas exercise a deleterious effect upon books, and especially upon their bindings; the incandescent electric light cannot have this effect because, as everybody knows, it is hermetically sealed. Some quantitative experiments have recently been carried out by J. Wiesner which clearly show the superiority of illumination by electricity. He found that after an exposure of 552 hours to an electric light of 144 candle-power no yellowing of the leaves or covers of books was observed, whilst with an exposure of 240 hours duration to the action of a 50 candle-power gas light produced a noticeable degradation of tone. Moreover, even when no apparent action is observed, the fact that injury has taken place can be demonstrated by treating the exposed paper with potash solution, this will at once develop the stain. The tensile strength of paper diminishes very considerably during the process of yellowing. Wiesner found that strips of paper 45 mm. long and 15 mm. wide had the following breaking weights:—

1.	Before exposure to gas light ...	3,485 grm.
2.	After attaining a pale yellow colour	2,865 „
3.	„ „ brown colour ...	2,345 „

He concludes therefore that the incandescent electric light is the best form of artificial illumination for use in libraries. Arc lamps are not considered to be so suitable.

Harness Interviewed.—This is the title of an article in *Science Siftings*, dated September 17th, written by G. W. de Tunzelmann, who is fortunate enough to show his competency for the task by hanging on to his name "B.Sc., M.I.E.E., Principal of the Penywern House Military and Engineering College." The interview, to the reader, is disappointing in the extreme, and finishes with an expression of opinion from the writer that the belt submitted to him was incapable of maintaining continuous electric currents through the body, and that, as arranged, it could not even claim to be considered an electrical appliance at all. This is nothing fresh; we have always said as much and a good deal more, and Mr. Gatehouse's recent tests conclusively proved what M. de Tunzelmann simply surmises. The editor, in a footnote, says, "More of this next week; we commenced the subject in No. 42." Just so, and the ELECTRICAL REVIEW began its crusade against these same apparatus five years ago. Moreover, those who are conversant with the recent law case between the Medical Battery Company and Mr. Jeffery, may have just a slight suspicion that Mr. de Tunzelmann's extremely weak article is based upon the report of that trial, and our own experiments and comments thereon.

Crystal Palace District Electric Lighting.—At a recent meeting of the Beckenham Local Board, it was stated that the conditions of order as to date for supplying current had not been complied with in the Crystal Palace district, and the company were liable to be fined £5 a day, and have the order cancelled. It was agreed that the Works Committee consider what steps should be taken.

Fatal Electric Car Accident at St. Louis.—A fatal accident occurred in one of the streets of St. Louis last Tuesday on the electric tramway. As the motor car, with passenger car attached, was going down a steep gradient, the man in charge lost control over the motor, and the cars rushed down the incline at a frightful speed. Turning a curve the rear car ran off the rails and upset, hurling the passengers out into the street with such force that one was killed on the spot, while 17 others were injured, five of them so severely that they are not expected to survive.

Failure of the Electric Light.—The Brush Electrical Engineering Company write from their Manchester Office as follows :—"We have with much surprise noted the paragraph in your issue of September 9th, under the heading of 'Failure of the Electric Light at Bilston,' stating that 'The electric light . . . . has proved a failure.' To stigmatise the matter in this way is most unfair to us, and we must ask you to again notice it, in its true aspect. The history of this installation is as follows :—The plant was very hurriedly fixed and was not complete on the opening day, owing to the short notice given us, but we ran the machinery notwithstanding, and have done so continuously since. We had some slight difficulties at first, as is sometimes the case when both arc lamps and incandescence are run in parallel from the same dynamo ; also one unfortunate stoppage due to a hot bearing. Except for these, the installation, as a whole, has been satisfactory and is now complete in every detail." We are pleased to insert this explanation which completely clears up the matter.

Fireproof Insulation.—In an interesting article by Mr. R. A. Fessenden in the New York *Electrical World*, the method of obtaining a fireproof insulation for wires is explained. The importance of an insulating material which will resist fire can hardly be exaggerated, and we are likely to hear more and more about it in the future. Mr. Fessenden says :—The method which it was actually proposed to use, and for which, by Mr. Edison's orders, the plans for a factory to produce 1,000 lbs. per day were drawn up, is as follows :—100 parts linseed oil, 50 parts strained Mexican asphalte, and 10 parts zinc chloride, are boiled down at 300° C. till all the zinc chloride has combined with the other materials. The mixture is then put in a sort of ice cream freezer, and stirred up while 50 parts of antimony pentachloride are run in, the mixture being kept cool by a water jacket. After stirring for an hour, boiling water is run in, and the mixture heated by passing steam into the water jacket. After mixing for another hour all the free acid will be found to be washed out, and the material is then ready to be applied to the wire. This gives a dark product, however, and is, moreover, more expensive than the products obtained by simply passing chlorine into hydro-carbons, and then washing them. Pentachloride of antimony costs 10 cents per pound and zinc chloride about 12 cents, so that the total cost of a pound of the fireproof material described above is about 25 cents per pound, exclusive of labour, which will probably add 15 cents more. I should say that this method of making a fireproof insulating material, though invented and worked out by the writer, is the property of Mr. Edison, the work having been done by the writer while employed in his laboratory for that purpose. This account would not, therefore, have been published but for the fact that while it is now four years since the process was worked out, nothing appears to have been done in the matter since the writer left that company, and it seemed a pity that what is believed to be a most useful process should become a lost art. It may be mentioned that the gases given off from these materials when heated to such a temperature as to cause decomposition will not support combustion. For instance, if wood shavings are partly covered with the composition, and placed in a box and lit, so soon as the grayish decomposition vapours begin to come off freely the fire is put out.

NEW COMPANY REGISTERED.

Kennedy Storage Battery Company, Limited.—Capital, £100,000 in £1 shares. Objects : To enter into and carry into effect an agreement expressed to be made between Messrs. Patrick Kennedy and C. J. Diss, of the one part, and the company of the other part, to acquire certain letters patent for "Improvements in Secondary or Storage Batteries," and to carry on the business of electricians, electrical engineers, electrical and mechanical engineers, suppliers of electricity, and manufacturers of electrical apparatus. Signatories (with 1 share each) : W. J. Sutherland, Seaford, Sussex ; J. Dunham-Massey, 55, Old Broad Street, E.C. ; G. C. A. Kohler, 17, Fenchurch Street, E.C. ; H. J. Alfred, 20, Moorgate Street, E.C. ; G. M. Gordon, 34, Colby Road, S.E. ; W. Simpson, Wivenhoe, Wood Green ; L. L. Simpson, 26, Dover Street, W. The number of directors is not to be less than five, nor more than ten, the first being appointed by the signatories ; qualification, 500 shares ; remuneration to be fixed by the company in general meeting. Registered on the 24th ult. by C. H. Hodges, 12, New Court, Carey Street, W.C. Registered office, Broad Street House, E.C.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Manchester Edison-Swan Company, Limited.—The annual return of this company, made up to July 18th last, was filed on the 26th day of the same month. The nominal capital is £550,000, divided into 50,000 "A" shares of £9 each, and 10,000 "B" shares of £10 each. 20,000 of the "A" shares, and all the "B" shares have been taken up, and £1 called upon each of the "A" shares, whilst the full amount has been called on all the "B" shares. The full amounts have been paid, amounting to £120,000. Registered office, 14, St. Anne's Square, Manchester.

Siemens Brothers and Company, Limited.—The annual return of this company, made up to July 1st, has been filed. The original capital of the company was £400,000 in £100 shares ; but by special resolution passed January 8th, 1883, and confirmed January 23rd following, the capital was increased to £500,000 by the creation of 1,000 new shares of £100 each. All the shares have been taken up, £85 per share called, and all calls (£425,000) paid or considered as paid, no difference being made in the return between the amount paid and that considered as paid. From other documents it appears that 3,993 shares were issued with £75 considered as paid on each share.

River Plate Electricity Company, Limited.—The annual return of this company, made up to June 30th, was filed on July 9th. The nominal capital is £500,000, divided into 49,900 ordinary shares of £10 each, and 1,000 founders' shares of £1 each ; 13,557 of the ordinary shares, and 892 of the founders' shares, have been taken up, £10 having been called up on each of 11,157 ordinary shares, and £1 on each of the 892 founders' shares. The full amounts called have been paid, and £24,000 agreed to be considered as paid on 2,400 of the ordinary shares. Registered office, 86, Gracechurch Street, E.C.

Telephone Company of Austria, Limited.—The annual return of this company, made up to the 16th ult., was filed on the 18th ult. The nominal capital is £200,000, divided into 20,000 ordinary shares of £5 each, and 20,000 preference shares of £5 each. 11,703 of the ordinary shares and 7,358 of the preference shares have been taken up, and £5 called on 150 of the ordinary shares, and £5 on all the preference shares, and the full amounts called have been paid. Registered office, 53, New Broad Street, E.C.

Priestman Oil Engine American Syndicate.—The annual return of this company, made up to February 8th last, was filed on May 31st. The nominal capital is £25,000 divided into 2,500 shares of £10 each. 2,450 of the shares have been taken up, and £10 called upon 1,200. The full amounts called have been paid, and £12,500 has been agreed to be considered as paid on 1,250 of the shares. Registered office, Temple Buildings, Kingston-upon-Hull.

THE TELEPHONE.

THE following correspondence appeared in last Tuesday's *Times*. We refer to the matter in our leader pages:—

Sir,—My friend the Duke of Marlborough has written a very interesting letter on the subject of the telephone problem, but I must be excused if I point out that he has left practically untouched the single specific point which I raised—namely, why has he abandoned his clearly-defined position, which was, that an efficient and remunerative telephone service could and would be provided in London by his company at a £10 rental?

As stated in my former letter, I do not desire to enter into other questions raised by the Duke of Marlborough. On a fitting opportunity I should like nothing better than to traverse his whole position. But, borrowing his own metaphor, the lion and the lamb are now lying down together, and I do not desire to disturb them.

My reason for writing to you on the single point of the London tariff question was, that I consider that the New Telephone Company did vast harm to telephone enterprise by persistently encouraging the public to expect that which cannot possibly be realised under any conditions of which we have knowledge.

I am stated to be "pining" for a £10 telephone. My contention throughout has been that a £10 telephone for London was economically impossible. I desire to emphasise the fact that the proposal to provide one has been given up. Nor am I putting on my "tilting suit" in the sense of provoking a discussion. I threw down no gauge. The Duke of Marlborough himself invited criticism by his letter to you of the 20th, and I consider that in limiting myself to the one point, which most directly concerned the public interest, I was exercising a forbearance for which credit was due.

I am, yours, &c.,
F. FAITHFULL BEGG.

Bartholomew House, *September 7th.*

Sir,—Absence (travelling) has prevented my sooner re-entering the arena of discussion, to which you gave me access in your issue of August 24th.

The combatants of last year, representative of the National and the New Telephone companies (so the Duke of Marlborough tells us in his letter which you published on the 6th inst.), have now formed themselves into a "happy family."

It is difficult, however, to understand what is Mr. Faithfull Begg's present attitude in the "lists," his Grace having, as he says, withdrawn his "lieges;" but that gentleman has given no indication this year in his letter, which you published on the 3rd inst., whether he still believes (*vide* his letters in your issues of September 3rd, 8th, and 19th, 1891):—

First, that "the single-wire system prevails because no other is possible;"

Secondly, "that the Duke of Marlborough's telephone millennium is still far distant;" and

Thirdly, "that, if competition in London of a new and independent company came into existence (as the Duke once proposed should be the case), the whole of the plant of the National Telephone Company, valued at £1,250,000 (see Mr. Campbell Swinton's valuable letters in your issues of September 8th and 15th, 1891), might have to be 'condemned as useless.'"

Although Mr. Faithfull Begg, in your columns of September 19th, 1891, states, "Nor do I hold any brief for the National Company," he still seems to contend that a complete twin-wire telephone system (promised us over and over again by the Duke) cannot be carried on remuneratively in London on the basis of a £10 rental. It seems right the public should now know whether the Duke is correct in stating that all Mr. Begg's "roaring" last year was "on behalf of," and as the "champion" of, "his lion;" because, if it is so, that gentleman's further "tilting" on behalf of the public is discredited, and it is left for me to attempt "doughty deeds" in a cause in which the former combatants have turned out to be pretenders, as I have already attempted to show in my letter to you on the 24th ult. But before this combatant retires, he should be reminded that he has never yet attempted to refute Mr. Campbell Swinton's arguments—namely, that the valuation of the business of the United Telephone Company, worth, at the outside, £500,000, at £1,250,000, is palpably at the bottom, and is the motive of all the "roaring," as well as of some of the "bleating."

May I remind your readers that last year the bleating of the self-styled "lamb" took the following form in his letter to you on August 29th, namely, that the "lion's" system "was inferior and the cost was prohibitive," and "practically that no development of the telephone for social or business purposes existed, while the price was above the means of many;" and, moreover, it was demonstrable that perfect efficiency could be afforded "at a remunerative profit for a £10 a year subscription for the whole of London;" and, further, that "the New Company was about to promote a Bill with the object of establishing a complete twin-wire telephone service for the whole of London." In all this he was fully backed up by Mr. Bennett's letters to you of September 19th, 1891.

This year his Grace, having proved to the lion that his lambskin concealed a carnivorous nature, deprecates any more "roaring," and (may I again say) "lets the cat out of the bag," and, while ignoring the rather serious indictment contained in my previous letter to you, endeavours to divert public attention by some gloved sparring with his friend the old "lion," which, however, lets us see a little further behind the scenes. His own words require no comment:—

"The lion thus observed that the lamb might possibly at a not distant day grow up to be a dangerous rival lion. . . . . Private friendships and mutual appreciation . . . . promoted peace. . . . . The lion has had to climb down along a very comfortable road we have made for him, along which we propose to proceed together, if possible, as very good business friends. . . . . To-day the lion" (the National Company), "is good enough to lie down with its despised brother" (the New Company).

The Duke, once the public champion, now deprecates "working himself into fiddle strings" by rushing into a contest which would mean competition everywhere. He can no longer hold out the bait of reduced prices as well as increased efficiency, which formerly gave him the right to that position, but he still promises that the telephone "is going to become in a few years a marvellous institution, which will confer 'perfection' on the public" in the form of "a first-rate telephone system throughout England."

He asks for time to do this.

I ask, is the old lion likely to be less wily now that he is to run in harness with the gentle lamb.

It seems, in my humble opinion, Sir, that after 12 years, during which the growth of a monopoly has only been kept in check by the existence of the Telegraph Acts (as demonstrated in the late correspondence), no more time should be given to the riveting of our chains by a combination which is probably stronger and better organised than ever.

Last year most of your correspondents deprecated the telephone being taken out of the hands of private enterprise. So long as competition, which the licence system contemplated, was insured, no one could have been stronger than I was on that side. But absence of competition, I fear, now cuts away all their excellent arguments in that direction.

If, as is absolutely clear, all the Duke's assertions point to one great telephone system controlled and connected up by the Post Office with an independent organisation for the local work, the position of which is unassailable for a term of years, and to a divided responsibility, where is the public benefit?

Much better have it all under the great Department of the State, which has long proved its unrivalled competency?

Every day the difficulty and expense of acquisition will become greater.

Either Sir Donald Currie or Dr. Cameron, both of whom in the past have clearly grasped the importance of this question from a national point of view, might now, on public grounds, take it up seriously and carry it forward.

Meantime, I am, your obedient servant,
C. E. WEBBER.

BUSINESS NOTICES, &c.

The Electric Light in the West End.—Since our last report upon the progress of electric lighting there has been a most noticeable increase in the number of new installations, especially for the lighting of private residences. Probably the large amount of work being done at the moment is due to the fact that advantage is taken of this being the holiday season. Among the installations at present in hand, one or two are in the Strand district, namely, one at 110, Strand, W.C., by Mr. Arthur Browne, of 17, Kensington Court Place, W.C.; one in the premises of Mrs. E. Bull, dressmaker, 79, Strand, by Messrs. Mather Bros., of 278, Caledonian Road, N.; and one in the premises of Messrs. Parker & Halford, St. Martin's Lane, W.C., by Messrs. Smeeton & Page, of 65, Queen Victoria Street, W.C. —The residential district north of Oxford Street is the one referred to above, where the great development has taken place. Messrs. Wood and Co, of 55, Great Portland Street, are fitting up an installation in their own premises. The same firm is wiring the premises of Mr. F. Whittingham, hatter, 65, Great Portland Street.—Messrs. Benham and Son, of 66, Wigmore Street, are fitting up an installation at 34, Portland Place.—At 37, Portland Place Messrs. C. Mellier & Co., of Margaret Street, Cavendish Square, are busy on an installation, while at 43, Messrs. B. Verity & Son, of King Street, Covent Garden, are at work.—In Harley Street two installations are in hand, one at 79 being done by Messrs. Gilbert & Co., Hanway Street, W.; one at 98, by the Brush Electrical Engineering Company. The latter company are also engaged on an installation at 21, Devonshire Place, W.—Messrs. F. & C. Osler, of 100, Oxford Street, are busy upon an installation at 30, Wimpole Street, while Messrs. Laing, Wharton & Down are at work fitting up 2, Mansfield Street, W.—11, Nottingham Place, W., is being installed by Messrs. W. T. Goolden & Co.—Messrs. C. Mellier & Co., of Margaret Street, are also at work on an installation in Cavendish Place.—Messrs. E. L. Berry, Harrison & Co., are fitting up the premises of Messrs. Goodman, 7, Coventry Street, W.C.

New Catalogues.—A new catalogue of electrical apparatus has been prepared and published by Messrs. Dorman & Smith, of Salford. In a prefatory notice they announce that they have acquired large works in Salford, which are now in full swing, and which are said to be the most complete of their special branch of the electrical industry in the country. In commenting on this catalogue, we are convinced that to its preparation much time and trouble has been devoted. As a catalogue of the smaller electric light accessories and fittings, which is the firm's special line, the book is very complete. Numerous illustrations are given, in fact almost every article mentioned is very clearly shown. Everything is fully described and priced. Some of the fittings we especially notice are lampholders, guard carriers, D. & S. switches, Siemens's carbon-break switches, accumulator regulators, D. & S. switchboards, wall sockets, ceiling roses, and pendants. The catalogue, as well as doing Messrs Dorman & Smith credit, will, we feel sure, be useful to all buyers of electrical fittings, of any description. To the new works mentioned above Messrs. Dorman & Smith have removed; their head offices are now at Ordsal Station Electrical Works, Salford.

The Tenders for Whitehaven Electric Lighting Plant.—At last week's meeting of the Whitehaven Town Council the Electric Lighting Committee recommended that the tender of Messrs. Ramsay Brothers (being the lowest) be accepted. For two boilers, tenders were received from Messrs. Galloway, Limited, Manchester; Messrs. Adamson and Co., Manchester; and Messrs. The Lowca Engineering Company, Parton. Recommended that the tender of Messrs. Galloway, Limited, be accepted. Recommended that the tender of Messrs. Willans and Robinson for four sets of Willans engines and Crompton's dynamos be accepted. For conductors, tenders were received from the International Okonite Co., Manchester; Messrs. Latimer Clark, Muirhead, and Co., London; and Messrs. W. T. Henley & Co., North Woolwich. Recommended that the tender of the International Okonite Company (being the lowest) be accepted. The acceptance of the above tenders to be subject to the sanction of the Local Government Board being obtained to the loan applied for. The council agreed to leave the matter over for further consideration before coming to any decision.

In re **Poole & White, Limited.**—Counsel on behalf of Mr. H. W. Herve applied on Wednesday to Mr. Justice Bruce, sitting as the Vacation judge, for a winding up order. The defendants were electrical engineers, and started with a nominal capital of £20,000; they also issued debentures to the amount of £30,000. The petitioner's claim was for £200 for goods sold and delivered, and met by a bill which became due on August 23rd, which was not honoured. Petitioner also held another bill for £200. In July a receiver was appointed on behalf of the debenture holders to take possession of the defendants property, and he had taken possession. Counsel for a creditor for £600 supported the petition; and yet another counsel for a creditor for £1,800 said he was instructed to take a like course. No one appearing for the defendants, his Lordship made the usual order.

Tenders Wanted—Bristol.—Tenders are invited for building a central station at Temple Back, Bristol, in connection with the electric light works, for the Bristol Urban Sanitary Authority. Plans may be seen and specifications, forms of tender, and bills of quantities obtained on payment of £3, which will be returned if a tender is duly delivered, at the offices of the architect, Mr. Henry Williams, 21, Clare Street, Bristol, on and after 17th inst. Tenders must be made on the prescribed form and delivered at the office of the Sanitary Authority, 51, Prince Street, Bristol, by 4 p.m. on October 10th, accompanied by a bill of quantities on the prescribed form, and endorsed "Tender for Central Station." Mr. D. Travers Burgess, town clerk.

Personal.—Mr. W. H. Stevenson, A.I.E.E., has resigned his occupation as country traveller to Messrs. Woodhouse & Rawson United, Limited, and accepted a position as town traveller with Messrs. Laing, Wharton & Down, of 82a, New Bond Street, W.

Mr. Chas. Hibbert, of the India-Rubber Company's works, at Silvertown, has been appointed "Works Manager" to the International Okonite Company's works, at Newton Heath, Manchester.

We hear that Mr. Louis Broekman, after ten years' connection with Messrs. Woodhouse & Rawson, has resigned his position as supply superintendent there, and has been appointed manager of the Epstein Electric Accumulator Company, Limited.

Electric Pumping Plant in Mines.—Last week an electric plant for pumping was started at the Aberdare-Merthyr Colliery, Hirwain. The plant was supplied by the Crompton-Howell Electric Light, Power, and Storage Company, Limited, Llanelly, under the management of Mr. G. Beith, of Pontypridd. The electric power is supplied by one of Crompton's compound dynamos, driven by one of Marshall & Sons' engines. The power is conveyed to the pumps, which are about 2,000 yards from the surface, by means of cable supplied by Messrs. Callender & Co. The pumps, three in number, were built by Messrs. Warner & Son, Walton-on-the Naze.

Private Electric Lighting.—Colonel Sir Edward Hill, K.C.B., M.P., has just had his residence, Rookwood, Llandaff, fitted throughout with the electric light, the installation being the work of Messrs. Drake & Gorham, of 66, Victoria Street, London. The new illuminant has proved completely successful. The power is derived from a 7 horse-power nominal "Otto" gas engine. This engine drives an 8 unit dynamo (by the Electric Construction Corporation). The accumulator is capable of supplying 80 lamps of 16 candle-power each for nine hours, or 125 lamps of 16 candle-power for four hours.

Lowdon Brothers.—On Tuesday last the first contract was made for the electric light installation in connection with the public electric supply in Dundee. Mr. James Ramsay, jeweller, High Street, is to have his premises illuminated with the new light, and the equipment will be furnished by Messrs. Lowdon Brothers, engineers and electricians, Dundee. Messrs. Lowdon are extremely busy just now, many of the factories in the city having the electric light introduced or extended in view of the coming winter.

The Electric Light at Greenock.—In connection with the rebuilding of extensive storage premises by the Orchard Sugar Refinery Company at Greenock, on the site of those which were recently destroyed by fire, it has been resolved to introduce the electric light, not only in the store but throughout the whole of the refinery. The work of erecting the installation has been entrusted to Messrs. Norman & Co., Limited, Glasgow.

Electric Launches.—We are informed by Messrs. Woodhouse & Rawson United, Limited, that one of the latest additions to their showroom at 34, Cannon Street, is an exact working model of the well known electric launch, *Glowworm*, which was recently designed and built by them at their Strand Works, Chiswick, for Mr. Andrew Pears, and which was the object of so much admiration at the last Henley Regatta.

H. Binko & Co.—We learn that the contracts for the supply and fitting with electric light of three of the largest buildings in the City of London, namely, Leadenhall House, New Zealand Chambers, and Billiter Avenue Buildings, comprising over 1,500 16-candle-power lights, have been signed this week by Messrs. H. Binko & Co., of 34, Leadenhall Street, E.C.

New Branch.—A new branch and show room has been opened in Hull by Messrs. Woodhouse & Rawson United, Limited. It is at 13, Paragon Arcade, and is managed by Messrs. Horne and Livingstone, under the superintendence of the company's branch at 41, Piccadilly, Bradford, Yorkshire.

The Western Union Telegraph Company.—A new office has been opened at 40, Mark Lane, E.C., by this company, for the reception and delivery of messages for and from all parts of North, Central, and South America, Canada, Bermuda, Bahamas, West Indies, &c.

Concentric Wiring.—Andrews's concentric wiring is being adopted in five of the chapels and dining halls of the colleges at Cambridge. This system has been adopted to avoid the disfigurement of the interior that would result by using wood casing.

Electrical Power Storage Company, Limited.—We hear that the order for all the batteries required for the Claybury Asylum has been placed with the Electrical Power Storage Company, Limited.

Electric Light at Pitlochry.—Messrs. A. & J. Macnaughton have just completed the successful installation of electric light in their Pitlochry tweed mills and warehouses.

CITY NOTES.

Direct Spanish Telegraph Company, Limited.

THE directors' report for the half-year ended June 30th, 1892, to be presented at the general meeting of shareholders, on Tuesday, September 20th, 1892, states that the accounts for the half-year ended June 30th, 1892, show after providing for debenture interest, a balance to the credit of profit and loss of £5,438 2s. 7d. The traffic receipts show a decrease of £45 5s. as compared with those of the corresponding period of 1891. They may, however, be considered satisfactory, as in the half-year of 1891, with which they are compared, the present reduced tariff had not come into force. The working expenses are £170 7s. 7d. in excess of those for the corresponding period of last year. The company's cables and the land-lines in connection with them, have continued in good working order throughout the half-year. After putting the usual sum of £2,500 to the reserve fund, the balance of profit and loss amounts to £2,938 2s. 7d. Out of this amount the directors recommend the payment of the dividend at the rate of 10 per cent. per annum on the preference shares, and a dividend at the rate of 4 per cent. per annum (free of Income-tax) on the ordinary shares. There will then remain a balance of £441 3s., which will be transferred to the reserve fund in part re-payment of the sum of £2,376 12s. 4d. taken from that fund towards the repairs of the Falmouth-Bilbao cable in November, 1891. The reserve fund will then amount to £29,827 2s. 10d. The dividend warrants will be issued on October, 1st, 1892.

Brush Electrical Engineering Company, Limited.—The directors of the Brush Electrical Engineering Company, Limited, have resolved to recommend to the shareholders that, subject to audit, a dividend at the rate of 6 per cent. per annum be declared on the preference and ordinary shares of the company for the six months ended June 30th, 1892, making, with the interim dividend paid last February, 6 per cent. for the year upon both classes of shares. The transfer books of the company will be closed from September 19th to 28th, both inclusive.

Stock Exchange Settlements.—The Stock Exchange Committee have appointed special settling days as under:—Monday, September 19th, Metropolitan Electric Supply Company, Limited, £50,000 5 per cent. debentures; New Telephone Company, Limited, ordinary shares, Nos. 25,901 to 74,700. The above have also been ordered to be quoted in the official list.

W. T. Henley's Telegraph Works Company, Limited.—A dividend at the rate of 7 per cent. per annum on the preference shares of this company, for the six months ending June 30th last, will be paid on October 1st prox.

New Telephone Company, Limited.—Share certificates will be received at the offices, 110, Cannon Street, E.C., in exchange for bankers' receipts on or after Wednesday, the 14th inst.

Commercial Cable Company.—A quarterly dividend at the rate of 7 per cent. per annum, is announced payable on October 1st.

TRAFFIC RECEIPTS.

The City and South London Railway Company. The receipts for the week ending September 11th, 1892, amounted to £768; corresponding month, 1891, £665, increase £103; total receipts to date for half-year, 1892, £8,458; corresponding period, 1891, £7,734; increase £724.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending September 9th, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brasilian Telegraph Company, Limited, amounted to £2,735.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Issue.	Name.	Stock or Share.	Closing Quotation, September 8th.	Closing Quotation September 15th.	Business done during week ending September 15th, 1892. Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	100 — 103	100—103	101⅝	101½
1,300,980*l*	Anglo-American Telegraph, Limited	Stock	48 — 49	48 — 49	48	...
2,849,510*l*	Do. do. 6 p. c. Preferred	Stock	89 — 90	89 — 90	89⅞	89
2,849,510*l*	Do. do. Deferred	Stock	10⅛ — 10⅜	10 — 10⅛	10⅛	...
130,000	Brazilian Submarine Telegraph, Limited	10	11¼ — 11⅜	11¼ — 11⅜	11⅜	11¼
53,200*l*	Do. do. 5 p. c. Bonds	100	100 —103	100 —103	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 —107	103 —107	...	...
77,978	Brush Electrical Engineering Ordinary, Nos. 1 to 63,416	3	3⅛ — 3⅜	3⅛ — 3⅜	3 5/16	3
69,996	Do. do. Non cum. 6 p. c. Preference, Nos. 1 to 63,416	2	2⅛ — 2⅜	2⅛ — 2⅜	2 5/16	2
40,000	Chili Telephone, Limited, Nos. 1 to 40,000	5	3 — 4	3 — 4	...	...
50,000	City and South London Railway, Nos. 1 to 50,000	10	2½ — 3½	2½ — 3½	...	...
30,152	City of London Elec. Lighting Co., Ltd., Ord. 40,001-70,152 ...	10	10 — 10½	10½ — 11	10 11/16	10½
$7,716,000	Commercial Cable, Capital Stock	$100	160 —165	155 —165xd	...	..
224,850	Consolidated Telephone Construction and Maintenance, Limited ..	14/-	3/16 — 3/8	3/16 — 3/8	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Cum. Pref. Shares, Nos. 1 to 20,000	5	5½ — 6	5¼ — 5⅜	5⅜	5⅜
16,000	Cuba Telegraph, Limited	10	11 — 12xd	11 — 12	...	...
6,000	Do. do. 10 p. c. Preference	10	17 — 18xd	17 — 18	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3¼ — 3⅜	3¼ — 3⅜	...	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	9⅜	...
60,710	Direct United States Cable, Limited, 1877	20	11½ — 11⅝	11½ — 11⅝	11⅝	11 1/16
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14 7/16 — 15⅛	14 7/16 — 15⅛	15⅛	14
70,000	Do. 6 p. c. Preference	10	15½ - 16	15½ - 16	16	15⅝
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	106 — 109	106 —109	107½	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	110 —113	110 —113	...	...
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	15 — 15¼	15 — 15¼	15 3/16	15
78,300*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	103 —106	103 —106	...	...
276,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	103 —106	103 —106	...	...
320,000*l*	Do. 4 p. c. Debenture Stock	Stock	108 —111	108 —111	...	...
135,000*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	103 —106	103 —106	...	...
180,400*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	103 —106	103 —106	104	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	103 —106	103 —106	104	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	4½ - 5	4½ - 5	4¾	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	... ...	... ..	...	...
66,750	Elmore's French Patent Copper Depositing Co., Ltd, Nos. 1 to 66,750	2	7/8 — 7/8	½ — ¾	¾	...
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	2⅜ — 2⅝	2¼ — 2½	2⅜	2 5/16
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd,	2	1½ — 1⅝	1⅛ — 1⅜	1 3/16	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 10s. only paid)	5	2 — 3	2 — 3	...	..
180,227	Globe Telegraph and Trust, Limited	10	10¼ — 10½	10¼ — 10½	10⅜	10½
180,042	Do. do. 6 p. c. Preference	10	15⅜ — 15⅝	15⅜ — 15⅝	15 5/16	15¼
150,000	Great Northern Tel. Company of Copenhagen	10	18½ — 19	18½ — 19	18 5/16	.
220,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105 —108xd	105 —108	105	...
12,134*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	5½ — 6½	5½ — 6½	...	...
9,600*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	9½ — 10½	9½ — 10½	...	...
41,600	India-Rubber, Gutta Percha and Telegraph Works, Limited ..	10	21½ — 22½	21½ — 22½	22½	21¾
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	104 —106	104 —106	...	...
17,000	Indo-European Telegraph, Limited	25	42 — 44	42 — 44	43¾	43⅜
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	2½ — 3½	2½ — 3½	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	6 — 7	6 — 7	...	...
30,000	†Liverpool Electric Supply, £3 paid	5	3 7/16 — 3 9/16	3 7/16 — 3 9/16	...	...
10,000	Do. do. fully paid	5	5 1/16 — 5 3/16	5 1/16 — 5 3/16	5⅛	4⅞
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6 — 7	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	105 —108xd	105 —108	...	...
49,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£9 paid)	10	6¾ — 7¼	6½ — 7	...	...
50,000	Do. 5 p.c. debentures, 1 to 5,000 in bonds of £10, £20, £40	...	... ...	102 —105	...	...
447,234	National Telephone, Limited, Nos. 1. to 438,984	5	4⅜ — 5	4⅜ — 5	4 15/16	4⅜
15,000	Do. 6 p. c. Cum., 1st Preference	10	13⅞ — 14¼	13⅞ — 14¼	14⅛	...
15,000	Do. 6. p. c. Cum. 2nd Preference	10	13¼ — 13⅜	13¼ — 13⅜	13 3/16	13¼
420,000*l*	Do. 4½ p.c. Deb. Stock Prov. Certs. fully paid ...	...	109 —111	109 —111	110½	109⅝
48,000*l*	New Telephone, Limited, Nos. 25,901 to 74,700 ... (£2 paid)	10	... ...	1¼ — 1⅜	...	...
6,318	Notting Hill Electric Lighting Company, Limited, fully paid ...	10	4 — 5	4 — 4½	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	3/16 — 5/16	3/16 — 5/16	...	...
9,000	Reuter's Limited	8	7 — 8	7 — 8	...	...
18,680	St. James's & Pall Mall Electric Light Co., Ltd., Ord., 101—18,780	5	7¾ — 8¼	7⅞ — 8¼	8⅛	...
20,000	Do. do. 7 per cent. pref., Nos. 20,081 to 40,080	5	8 — 8½	8 — 8½	...	...
3,381	Submarine Cables Trust	Cert.	116 —121	116 —121	118½	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	3½ — 4	3½ — 4	3 11/16	...
37,350	Telegraph Construction and Maintenance, Limited	12	42 — 44	43 — 45	44½	43½
150,000*l*	Do do. do. 5 p. c. Bonds, red. 1894	100	103 —106	103 —106	...	...
58,000	United River Plate Telephone, Limited	5	1 — 2	1 — 2	...	...
146,370*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	85 — 95	85 — 95	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	6½ — 7½	6½ — 7½	...	...
271,400*l*	Do. do. do. 5 p. c. Debentures	100	100 —103xd	100 —103	100½	...
30,000	West Coast of America Telegraph, Limited	10	3 — 4	3 — 4	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	102 —106	102 —106	...	...
67,007	Western and Brazilian Telegraph, Limited	15	9 — 9½	9 — 9⅜	9⅜	...
30,364	Do. do. do. 5 p. c. Cum. Preferred	7½	6¼ — 6⅜	6¼ — 6⅜	6⅜	6⅜
30,364	Do. do. do. 5 p. c. Deferred	7½	2⅜ — 3¼	2⅜ — 3¼	3¼	...
189,700*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	103 - -106	103 —106	...	...
237,200*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	103 —106	103 —106	...	...
88,321	West India and Panama Telegraph, Limited	10	1⅛ — 1⅜	1 — 1¼	1¼	1⅛
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	9¼ — 9⅜	9¼ — 9⅜	9⅜	9 5/16
4,669	Do. do do. 6 p. c. 2nd Preference ...	10	8 — 9	8 — 9	...	...
80,000*l*	Do. do. 5 per cent debentures (1917) No. 1 to 1,000	100	101 —105	101 —105	103	...
$1,536,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	123 —128	123 —128	...	...
173,100*l*	Do. do. 6 p. c. Sterling Bonds	10	97 —102xd	97 —102	...	...
59,900	*Westminster Electric Supply Corp., Ord., Nos. 101 to 42,953 ...	5	5⅜ — 6¼	6 — 6⅛	6 3/16	...

* Subject to Founders' Shares. † Quotations on Liverpool Stock Exchange. BANK RATE OF DISCOUNT.—2 per cent. (April 28th, 1892).

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED:—Blackpool Electric Tramway Company, Limited, £10 (£6½ paid 7½—7⅝.—Electric and General Investment, shares of £5 (£1 paid), 2⅜—3¼.—Founders' shares, 200—225.—Elmore Foreign and Colonial Copper, Founders shares, 6⅜—7¼.—European Sims-Edison Torpedo Company, shares £20 (fully paid), 20—20½.—Founders' shares, 10—20.—Halifax and Bermuda Cable 4½ per cent. bonds 80—90.—House to House Company (£5 paid) 2½—3½.—Kensington and Knightsbridge Electric Lighting Company, Limited, Ordinary Shares £5 (fully paid), 5⅜—6, 1st Preference Cumulative 6 per cent., £5 (fully paid), 5½—6.—Manchester, Edison and Swan Company, £9 (£1 paid), ⅛—¼.—Metropolitan Electric Supply Company, Foundors' Shares, 50—150.—Queen Anne's Mansions Lighting and Heating, Deferred shares of £10 (fully paid, 10—¼.—Do. 4½ per cent. preference shares of £10 (fully paid), 10—¼.—Do. Debentures, 103—¼.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), ¼—⅜ —£6 Preference (fully paid), 2¼—3.—Ward's Electric Car (£10 paid), 1⅜—1½.

WATER POWER.

By E. TREMLETT CARTER.

(*Continued from page* 330).

V.

19. *Theory of Impulse.*—It has been shown that the first part of the work done by the water on an overshot wheel, is performed by impulse or collision in the direction of motion. As this is also true of other forms of water-power engines, the theory of impulse will be completely discussed in so far as it relates to these engines. Considered mathematically, the conditions are those of a steady stream of particles colliding obliquely against a large body, which is moving against a resistance of such a magnitude that there is no acceleration; the collisions being inelastic. Let $d\,m$ be the mass of water striking the wheel, in the time $d\,t$, with an absolute velocity, V, along a path making an angle, α, with the direction of motion of the wheel at the point of entry. Let the mass of the wheel be M before the collision, and let the wheel be moving with a peripheral velocity, v, against a resistance which prevents acceleration. Let f be the effort exerted by the impulse of the water against this resistance. Then the time integral of f over the indefinitely short time, $d\,t$, gives the change of momentum of the system during that time; and f being constant, this integral is $f\,.\,d\,t$, whence

$$f\,.\,d\,t = (\mathrm{M}\,v + \mathrm{V}\,.\,\cos\alpha\,.\,d\,m) - (\mathrm{M} + d\,m)\,v.$$

Whence,

$$f = \frac{(\mathrm{M}\,v + \mathrm{V}\,.\,\cos\alpha\,.\,d\,m) - (\mathrm{M} + d\,m)\,v}{d\,t}$$

And the useful power is,

$$\mathrm{P} = f\,v = \frac{(\mathrm{M}\,v + \mathrm{V}\cos\alpha\,.\,d\,m)\,v - (\mathrm{M} + d\,m)\,v^2}{d\,t}$$

It is desired to make this a maximum, therefore

$$\frac{d\,\mathrm{P}}{d\,v} = \frac{(2\,\mathrm{M}\,v + \mathrm{V}\cos\alpha\,.\,d\,m) - 2\,(\mathrm{M} + d\,m)\,v}{d\,t} = 0$$

Whence,

$$2\,\mathrm{M}\,v + \mathrm{V}\cos\alpha\,.\,d\,m = 2\,(\mathrm{M} + d\,m)\,v$$

And

$$v = \tfrac{1}{2}\,\mathrm{V}\,.\,\cos\alpha.$$

The maximum useful impulse is obtained when the water flows into the buckets at as small an angle as possible, and when the velocity of the wheel is equal to half the velocity of the entering stream of water. As it is structurally impossible that cos α can be equal to unity, it is advisable that the velocity of the wheel should be a little more than half that of the water. In practice it is never less than 0·55 of that velocity, while many builders design the wheels to run at still higher, though less efficient, speeds.

The useful H.P. developed by the impulse of Q cubic feet per second against the wheel may be determined from the foregoing, and is equal to

$$\text{H.P.} = \frac{62{\cdot}4\,\mathrm{Q}\,(\mathrm{V}\cos\alpha - v)\,v}{550\,g}$$

Under the best conditions, the maximum H.P. due to impulse is

$$\text{H.P.} = \frac{62{\cdot}4\,\mathrm{Q}\,\mathrm{V}^2}{4 \times 550\,g}$$

Now, the original kinetic power of the water was,

$$\text{H.P.} = \frac{62{\cdot}4\,\mathrm{Q}\,\mathrm{V}^2}{2 \times 550\,g}$$

Whence, the maximum efficiency of impulse in an engine of this class is

$$\eta = 0{\cdot}5 = 50 \text{ per cent.}$$

It is impossible to utilise any more of the kinetic energy due to the guide-fall, and, in practice, even this amount is not fully realised. Some of the energy is necessarily carried away by the tail-water, which moves with the same velocity as the wheel, and some of it is wasted in heat on account of splashing and eddying in the buckets. We see therefore that the guide-fall should not be allowed to be very large; but other considerations enter into the determination of its best magnitude.

20. *Wheel-fall.*—The work done on account of the wheel fall will wholly be realised in the engine, provided none of the water escapes from the buckets before the bottom of this fall is reached. In well formed buckets and wheels moving at not too high a velocity, there is little or no loss on this account, and the power developed on account of the wheel-fall is,

$$\text{H.P.} = \frac{62{\cdot}4\,\mathrm{Q}\,h_2}{550}$$

The total H.P. realised in the engine is, therefore,

$$\text{H.P.} = \frac{62{\cdot}4\,\mathrm{Q}}{550}\left(h_2 + \frac{\mathrm{V}^2}{4\,g}\right) = \frac{62{\cdot}4\,\mathrm{Q}}{550}\left(h_2 + \frac{h_1}{2}\right)$$

Some of this will, of course, be wasted in the engine in overcoming friction of the moving parts; but this gives the maximum possible power. The highest possible efficiency, due to both impulse and weight is

$$\eta = \frac{h_1 + 2\,h_2}{2\,\mathrm{H}}$$

Thus, at a fall of 20 feet, if the guide-fall is 4 feet, the wheel-fall 15 feet, and the tail-fall 1 foot, the efficiency could not possibly exceed, and would probably be considerably less than

$$\eta = \frac{4 + (2 \times 15)}{40} = 0{\cdot}85$$

While, at the same fall, if the guide-fall was reduced to 2 feet, and the tail-fall to 6 inches, the limit of efficiency would be

$$\eta = \frac{2 + (2 \times 17{\cdot}5)}{40} = 0{\cdot}925.$$

It need scarcely be added that the commercial efficiencies would be very much below these figures; they would, however stand in something of the same proportion.

21. *Details of Overshot Wheels.*—These engines were formerly made of wood, but are now much more frequently made of sheet iron or mild steel. When constructed of metal they are much lighter and more efficient in proportion to the power they develop. The general arrangement of parts is shown in fig. 18. A drum or cylinder of sheet iron,

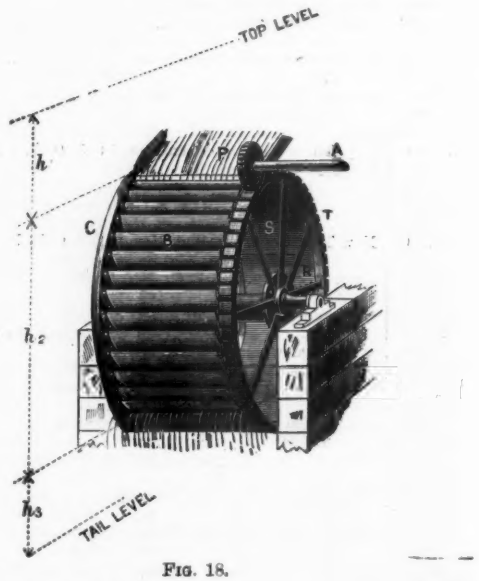


FIG. 18.

S, called the *sole*, is fastened at the edges to two ring-shaped flanges, shown at C and called the *crowns*. These are usually of plates of wrought iron of single or double thickness, and are provided with grooves or lugs for holding the buckets. A number of curved or angular plates of iron are fixed at equal distances into the space between the crowns, forming the buckets, B. If the wheel is very wide there is a third crown in the middle of the buckets. The arms of the wheel consist of a number of lengths of flat bar or angle iron, bolted to a pair of rosettes, R, on the shaft, and to flanges on the crowns; and the wheel is further supported by a number of cross ties of round iron, connecting each rosette with the

opposite crown, or in large wheels, with the middle crown. The rosettes are usually of cast-iron, and occasionally the shaft is of this material. The shaft is supported by means of a couple of bearings, fitted with rings to take off the end play, and mounted on foundations of solid masonry. Power is sometimes supplied to the machinery through this shaft; but more frequently it is taken off at the rim of the wheel by means of a pinion. By taking off the power at the rim, all transmission of the power through the shaft, and most of the transmission through the arms are avoided, and thus these details may be made much lighter. One of the crowns supports a set of segments of cast-iron spur teeth or cogs, completely enveloping the circumference of the wheel. Into these the small pinion, P, is geared, so that the motion of the wheel sets the pinion in rapid revolution. The proper place to put the pinion is on the loaded or descending side of the wheel, as in this position its upward thrust partially neutralises the downward pressure of the water on the wheel, thus reducing the load and the losses at the bearings. If placed on the ascending side the pinion will add to the load on the bearings, and will reduce the efficiency of the engine.

In order to determine the diameter of the wheel, the peripheral velocity must be decided upon. The considerations which affect this decision are mainly the efficiency and prime cost of the engine. If the wheel is allowed to run rapidly the guide-fall must be large, in order to give the water the necessary velocity, and the diameter of the wheel will be small. Moreover, its width will be small, because a narrow wheel will easily take all the water that is running without overfilling the buckets. Thus, with high peripheral velocities, the prime cost of the engine will be low, but the efficiency will also be low. On the other hand, if the wheel is run at a very slow speed it will have a diameter almost equal to the total available head, and it will also be very wide, because a narrow bucket would not be able to take all the water without excessive filling. The result would be a very expensive and heavy wheel, which, though theoretically efficient, would bear so heavily on the supports that a great deal of power would be wasted in friction. Clearly, there is a certain velocity which combines the greatest advantage of both prime cost and efficiency, and at which it is best to run the engine. This velocity depends on the magnitude of the head for which the wheel is to be built. Overshot wheels can well be built for heads varying from 10 to 50 feet, and have even been built for a head of 80 feet; the wheels for these varying from about 8 to 35 or 40 feet in diameter. With the smaller diameters there is a considerable centrifugal force on the water in the buckets, if they are run at as high a speed as the large wheels; and as this force tends to throw the water from the buckets before they reach the bottom of the fall it is to be avoided. It is found that a wheel of 20 feet diameter will run most efficiently at a velocity of about 10 feet per second; and since the centrifugal force varies as the square of the speed and inversely as the diameter, it follows that the velocity should vary as the *square root* of the diameter of the wheel. Other considerations often lead builders to design small wheels to run at lower velocities than are indicated by this rule; and wheels of 9 or 10 feet diameter are frequently run at from 2½ to 5 feet per second. With large wheels also, as has already been mentioned, a much higher velocity than is indicated by theory is frequently permitted, many wheels running just a little under the entrance velocity of the water. It will be well, however, to follow the lines indicated by theory, both in these papers and in actual design of engines. The only important consideration is to be sure that the theory takes account of all the conditions of the problem.

Allowing 10 per cent. loss of head in the guide, and an entrance velocity equal to that fixed by the theory of impulse, we have for the guide-fall,

$$h_1 = 1{\cdot}1\ \frac{v^2}{2\,g} = \frac{4{\cdot}4\ v^2}{2\,g\cos^2 a}$$

And for the wheel-fall,

$$h_2 = \text{H} - (h_1 + h_3)$$

The tail-fall need not be more than will give clearance between the wheel and the tail water if the buckets are not excessively filled. The water enters at a point about 2 or 3 buckets from the top of the wheel, the radius to this point making the angle θ with the vertical. Then,

$$r = \frac{\text{H} - h_1}{1 + \cos\theta}.$$

This gives the radius of the wheel in feet. It will next be necessary to determine its width. The volume of the space between the crowns which passes under the entering stream in one second is—

$$\text{S} = w\,.\,d\,.\,v\ \ldots\ .\ \text{cubic feet},$$

where d is the depth of the crowns and w is the width of the wheel, in feet. The quantity of water to be conveyed by this space in one second is equal to Q; but it would not do to allow Q to fill this space. For if the buckets are quite full at starting from the top, they will speedily discharge the greater part of the water before reaching a much lower point. Moreover, this space is partly filled by the metal plates of the buckets. It is usual to allow a *coefficient of fill*, or ratio between the quantity, Q, and the space indicated by the above formula. Calling f this coefficient, we have

$$\text{Q} = w\,.\,d\,.\,v\,.\,f.$$

Or,

$$w = \frac{\text{Q}}{d\,.\,v\,.\,f}$$

In large wheels the crowns are about 1 foot deep, and the value of f is taken as 0·34; and in small wheels these are 10 inches and 0·25 respectively. In order to allow of the easy escape of air from the buckets, these are made a few inches wider than given by the formula; there is also the additional width due to the crowns and gear to be taken into account.

The shape and number of buckets will now occupy our attention. In order that the water may not be thrown out of the wheel by having its velocity checked at the lip or mouth of the bucket, the direction of the lip should be such that the entering stream glides on to it and does not strike it at an angle. When well inside the wheel the water may be permitted to strike the bucket at a considerable angle, and thus to exert a useful impulse on the wheel. Some of the most common forms of bucket are shown in fig. 19. All

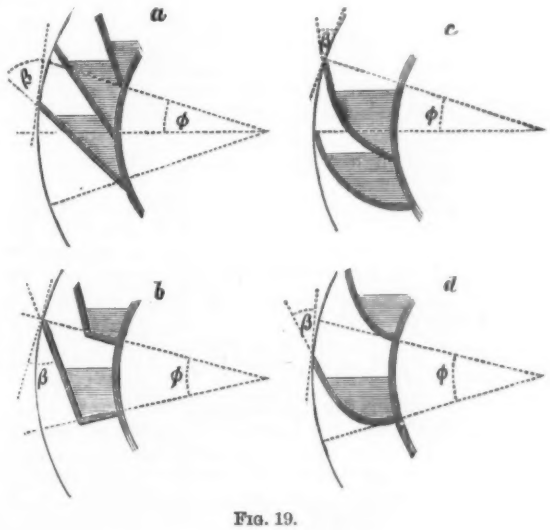


FIG. 19.

these present an angle, β, such that the jet *glides* on to them, at the lip. (*a*) is not a good form, because the impulse of the water is exerted entirely against the sole and there is no useful forward effort produced; (*b*) has two straight parts, one radial for half the crown-depth and the other inclined at the desired angle: it is a good form for wooden buckets; (*c*) and (*d*) are curved metal buckets, the former consisting of a portion of a circle, while the latter is curved more rapidly at the bottom than at the lip; the former is the cheaper, but the latter is the more effective in producing an easy entrance of the water. The angle, β, is, of course, the relative angle of approach of the stream to the bucket, and is caused by the compounded motions of the water and wheel in different directions. In fig. 20, let P be the point of admission of the water at any instant, and let X Y be the

tangent to the wheel at this point. Draw O P to represent the stream velocity in magnitude and direction, and O N to represent on a similar scale the direction and magnitude of the motion of the wheel. Then P N represents in a similar manner the relative motion of the water with respect to the moving wheel, and is called the relative velocity, v_r.

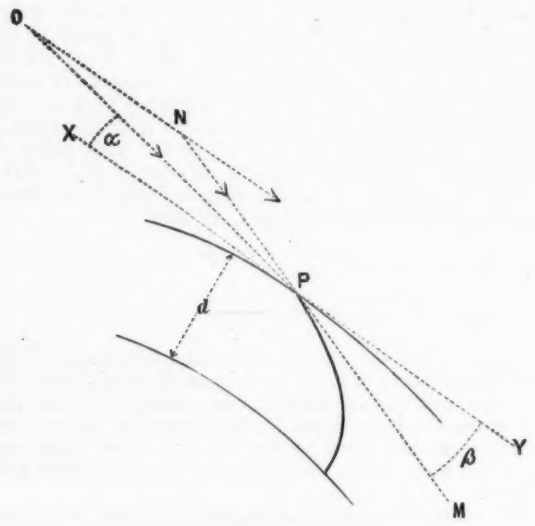


FIG. 20.

The angle, O, P, X, or α, is the *absolute* angle of approach, and the angle, N, P, X, or β, is the *relative* angle of approach. The line, N, P, should be tangent to the bucket at the lip. To get a high efficiency of impulse we must, as we have seen, make α very small; but there is a limit to the reduction of this angle, for the smaller it is the thinner must be the stream of entering water, in order not to take up more than a fraction of the width between the buckets. In practice the relative angle, β, cannot be much less than from 20 to 30 degrees for ordinary sizes of wheel, and from 5 to 20 degrees for very large wheels, while small wheels have a relative entrance angle of as much as 40 degrees. Now,

$$\sin \alpha = \left(\frac{k-1}{k}\right) \sin \beta$$

where k is the ratio of the absolute velocity of the water to that of the wheel. And since the angles for large and moderate sizes of wheel are not very great, no serious error will be introduced by taking the sines as proportional to the angles; at any rate, this is the usual practice in designing wheels of large size. Then,

$$\alpha = \left(\frac{k-1}{k}\right) . \beta,$$

or, where $k = 2$, α is equal to half β.

Having ascertained the angles of relative and absolute approach of the water to the bucket, and knowing the width and flow of the supply stream, we can find the thickness of the stream as measured tangentially to the wheel.

The orthogonal thickness of the entering stream is

$$t = \frac{Q}{w \, . \, v},$$

whence the thickness measured tangentially is

$$t_1 = \frac{Q}{w \, . \, v \, . \sin \alpha}.$$

Now this latter must not be as great as the distance between any one bucket and the next, *i.e.*, as the *pitch* of the buckets; for the stream must leave a certain space for the free escape of air. This thickness is, therefore, a little below the minimum pitch of the buckets, and we are at liberty to make the pitch anything greater if we think proper. The more buckets we have the less the loss of water at the lower part of the wheel-fall, but the heavier will the wheel become and the greater the splashing of water against the thickness of the buckets at the lips. With thin metal buckets we may have a greater number than with thick wooden ones, as the latter fill up more space with material than do the former. Practice varies between making the pitch 1·25 to 2·0 times the tangential thickness of the supply stream at full power; the most common practice being the simple mean of these two limits. We may therefore write

$$p = \frac{1{\cdot}5 \, Q}{w \, . \, v \, . \sin \alpha},$$

where p is the pitch in feet. Or

$$n = \frac{2 \pi r \, . \, w \, . \, v \, . \sin \alpha}{1{\cdot}5 \, Q},$$

where n is the number of buckets; taking, of course, the nearest whole number if not exactly integral.

The pitch angle, ϕ (see fig. 19), varies from 5 to 10 degrees for wheels of ordinary size; and the number of buckets is often made equal to five or six times the radius of the wheel in feet, for wheels up to 25 feet diameter, and four or five times for larger wheels.

The section of the shaft depends on the weight of the loaded wheel and on the shape which that section must have; it will also depend on whether power is taken off at the crowns or through the shaft. The diameter of a solid circular mild steel shaft, not transmitting power, to support a wheel of weight, W, with a distance L feet between bearing centres, is

$$d = 0{\cdot}29 \sqrt[3]{W \, . \, L} \text{ inches.}$$

The weight includes the water in the wheel at any moment at full load. If of wrought-iron the diameter should be 10 per cent. greater; or, if of cast-iron—remelted grey pig—it should be about 60 per cent. greater. A very common form of shaft is shown in fig. 21. It is stiffened at S with four ribs or feathers, and turned at B for the rosettes, R. The journals, J, are usually $\frac{3}{4}$ the diameter of the shaft at B. The modulus of resistance of the section must, of course, be equal to that of the solid shaft calculated from the foregoing equation.

Fixing the guide trough or shoot is a matter which involves some careful consideration, as, if it is not set at the right angle or is not the right length, the water will not enter the wheel efficiently. It will be assumed that the variation in the level of the top water is small, so that for all positions of the gate the velocity of the water will be sensibly the same. The water is to enter the wheel at an angle α with the tangent to the circumference, and at a point making the angle θ with the vertical; so that the angle of inclination of the stream to the horizontal must be the sum of these two angles, and the guide must be set accordingly. Where no guide is used the water describes a parabolic trajectory from the sluice to the wheel, and the position of the sill of the sluice relatively to the wheel can easily be determined from the geometry of that curve. In this case, if the head varies the point and angle of entry will also vary, and the efficiency of impulse will be reduced.

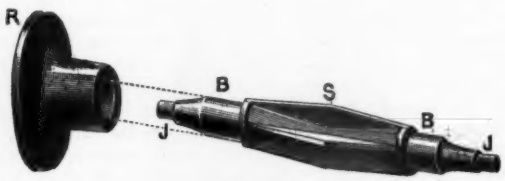


FIG. 21.

To assist the reader in the choice of an overshot wheel for any given head, the writer has compiled the following table of principal dimensions and constants, which is followed by a fully worked out example. While this type of water-power engine is not the most efficient nor the most compact, yet its simplicity, its cheapness, and the ease with which it can be erected and attended to, render it of use where more complicated machinery would not be possible. It has already done good work in electric lighting in other countries, and will probably, before very long, do good work of the same sort in this.

(To be continued.)

ELECTRIC AND CABLE RAILWAYS IN LONDON.

THE Corporation of the City of London recently issued a Blue-book dealing with the electric railway Bills introduced into the late Parliament, and but for the fact that at the time of its publication, public attention was otherwise occupied, it would, no doubt, have attracted a considerable amount of notice. It embodies a very exhaustive report by the Local Government and Taxation Committee of the Corporation, of which Mr. Henry Clarke is the chairman, and much information of interest to the inhabitants of London. Seven Bills were promoted, namely, the Great Northern and City Railway, the Central London Railway, the City and South London Railway, the Waterloo and City Railway, the Baker Street and Waterloo Railway, the Hampstead, St. Pancras, and Charing Cross Railway, and the Royal Exchange and Waterloo Railway. Of these, the Royal Exchange and Waterloo Railway Bill did not proceed beyond the preliminary stages; the Baker Street and Waterloo Railway, and the Great Northern and City, and the Central London Railway Bills passed through Parliament and received the assent of Her Majesty, and the other Bills have, by a standing order for the purpose, been suspended until next Session, when they can be again taken up at the committee stage. When the Bills were first introduced, those which affected the City were promptly referred to the Local Government and Taxation Committee, and the Corporation resolved to petition against them all, in order that they might be in a position to express their views in the fullest possible manner. The Committee had to consider, in the first place, that these railways were to all intents and purposes the introduction of a new system of railway communication in the Metropolis, and the fact that a very great responsibility rested upon them with respect to their future development. They had to avoid, on the one hand, the reproaches which might be cast upon them in the future that they had exhibited a lamentable lack of foresight when these railways were projected; and, on the other, the imposition of such onerous conditions upon the companies as would, at all events, retard, if not completely stifle, the enterprise in its inception. The Committee, therefore, proceeded with the utmost caution, and determined to be guided in the course they should pursue by the highest professional advice available.

Colonel Haywood's services were retained by the Corporation, and Mr. J. Wolfe Barry, an engineer of great experience in railway matters, was associated with him.

A series of nine questions was drawn up by the Committee, and the engineers were asked to report upon them. The first was as to the proper depth of all the proposed railways below the level of the blue clay, and upon that the engineers reported as follows:—

"It would appear, from examination of the Parliamentary sections, that it is intended that these railways should be made in the blue clay. It is important that this matter should be placed beyond the question of doubt by a proper series of borings made at short intervals, and that clauses should be inserted in the Bills requiring that no portion of the railway tunnels should be less than 10 feet below the undisturbed surface of the London clay, and defining the mode of tunnelling, and similar matters. Clauses of this nature were inserted in the Central London Railway Act of 1891."

A great deal depends upon the observance of these requirements, because it is said that if the tubes are placed at a sufficient depth in the blue clay, a building in the street under which the excavations are made would in no way be damaged, either by the construction or by the working of these railways. It is contended on behalf of the promoters of these electric railways that no vibration whatever will be experienced overhead.

The width of the tubes proposed by four of the Bills is as follows:—Central London Railway, 11 feet 6 inches; City and South London (Islington extension) Railway, 11 feet 6 inches; Waterloo and City Railway, 12 feet; Great Northern and City Railway, 16 feet. In connection with this subject, engineers point out that the tubes of the original City and South London Railway Company (authorised in 1884) were intended to have a diameter of 10 feet, and this diameter was sanctioned by the company's Act of incorporation. Subsequently the diameter was increased to 10 feet 6 inches, in the Act for the extension of the City and South London Railway to Clapham, passed in 1890. Last year, in the Bill for another extension of the same railway to Islington, the width proposed was 11 feet. The diameter authorised last year for the Central London Railway was 11 feet 6 inches.

There is no uniformity of proposal, and in their opinion the matter calls for careful attention.

The third question submitted was with reference to the adequacy of the proposed railways for future traffic. A large traffic can be carried by these railways; but it is equally true that, owing to the fact of there being a great depth below the streets, and consequently served by hydraulic lifts, and to the small size of the tubes proposed, they can scarcely be expected to be able to accommodate the traffic of London so satisfactorily and conveniently as an ordinary railway. It is the opinion of those well qualified to judge, that after a time all these railways will be found to be absolutely inadequate for the traffic that they are ultimately destined to attract. At the present time no physical connection is proposed between the projected railways and any of the trunk lines of railway, except in the case of the Great Northern and City Railway, which not only joins the Great Northern system, but running powers over part of the Great Northern Railway are sought in respect of it.

The Central London Railway of this year is an extension of the line authorised last year. Its City terminus is proposed to be in juxtaposition to the Great Eastern terminus at Liverpool Street, and near to Broad Street station; but no physical junction, *i.e.*, communication by rails, is proposed with either of those railways.

The City and South London (Islington extension) Railway is a prolongation of the existing line of the London and South London Railway Company. It will not join any other existing railway. The Waterloo and City Railway starts from Waterloo Station, but it is not proposed to make any junction with the London and South-Western Railway. The want of connection with existing railway systems is a matter which warrants careful attention, as, apart from questions of cost, it is evident that the convenience of the public would be better served by a series of railways communicating with each other, and with the suburbs, than by isolated lines between certain points within strictly urban districts, however advantageous such points of commencement and termination may be in themselves.

The South-Eastern Railway Company are offering a strenuous opposition to the Waterloo and City Railway scheme, because they fear that, if sanctioned, it will seriously injure their Charing Cross and Cannon Street branch. From a public point of view, it would be a distinct advantage to have such a railway, because a very long time is often occupied in going from Cannon Street to Waterloo Station, particularly in foggy weather, when the journey is not unfrequently protracted, and occasionally extends to three-quarters of an hour.

With reference to the railway companies being permitted to utilise any portion of the public way for access to their stations, the engineers replied that, as a general principle, it is a question whether railway companies should be allowed this privilege, unless it can be shown that the portions proposed to be utilised are not of value as accommodating the traffic of the streets, and that an overwhelming necessity exists for the appropriation of public property. As will be readily perceived, not one inch of space of the footways in the City can be spared, but the Corporation have practically sanctioned the utilisation by these railway companies of that large area in front of the Royal Exchange. As some compensation for this privilege, the companies have undertaken to construct subways from the Mansion House to the Bank, and these will not only be available for intending passengers by the railways, but also for such of the general public as desire to cross from one side of the street to another, and to avoid the danger involved in threading their way through the volume of heavy traffic which is constantly passing at this particular point. The exits and entrances to these subways will be railed off, and, fearing that this might be a source of danger upon Lord Mayor's Day and such similar occasions, the precaution has been taken to provide at each side a hydraulic apparatus by which, upon an attendant pressing a button, the railways may be lowered into the subway and the aperteres covered over in the short space of from 10 to 15 seconds. The difficulties of construction of the station at the Mansion House would appear to be great. They involve the provision of a subway about 250 yards in length below the street, in which new gas and water mains must be laid, and numerous sewers constructed in lieu of those which would be interfered with by the excavations. The connecting of the new and old mains and sewers would also be a serious undertaking. This subway is proposed to be 15 feet wide, and 8 feet 6 inches high, and its foundations would be 23 feet below the level of the streets. It would not be built in the London clay, but in the upper soil. It is impossible to say at the present time whether the construction of these subways, and of the station itself, might not necessitate the underpinning of some of the large buildings around the spot in question. At an rate, it would be a considerable undertaking in itself, and would be of totally different construction from the boring of the iron tunnels through the London clay for the railways themselves. Apart from these considerations is the question of the interference with street traffic during the construction of the station and subway. As these works might occupy a period of 18 months, or even longer, the whole of the traffic might have to be carried on timber platforms during that lengthy period. The removal of the soil, and bringing in of materials, would also have to be carefully considered. It is possible that some of these objects might be served by the construction of the tunnels, or some of them, before the station is commenced, so as to provide, by their means, for the removal of the soil, and the bringing of materials; but, however it is done, it cannot be doubted that serious interference with the traffic of the streets would have to be faced. The promoters are under obligation to do the work at night, and the company stated that the traffic of the streets during the whole progress of the works would not be interrupted for a single hour in the daytime. How this pledge is to be fulfilled it is not easy to say.

The City authorities have the absolute power of prescribing in every respect not only the size of the subways and their number, but the mode in which they are to be constructed, and their positions, and it is not competent to appeal from their decision. The eighth proposition was whether the proposed routes are the best in the interests of the public. The engineers think they are, but in saying this it must be understood that they do not express any opinion as to the details of the routes, or the manner in which special interests may be affected.

As to the uniformity of gauge, they are strongly of opinion that it should not only conform to the standard gauge of the country—namely, 4 feet 8½ inches—which they believe is in all cases proposed, but also that all the tunnels should be made of such dimensions as would enable the ordinary rolling stock of the country to pass through them. It may be quite true that at the present time junctions with existing lines are not proposed, but, looking to prudent provision for the future, they think that all railways through London should be capable of being joined to the railway system round London, which would be the case if the diameter of all the tunnels were made 16 feet, as proposed by the Great Northern and City Railway Bill. Such an enlargement would imply additional expenditure, but it appears desirable that before companies are permitted to run their lines under public streets, some distinct rules on this subject should be laid down.

The question should not be dealt with haphazard, but carefully

considered, as, in a similar case, the standard gauge of this country was settled by Parliament in 1846, after due investigation. It would, in the engineers' opinion, be unwise to take too narrow a view of this important matter, simply on the ground of first cost. This is a subject of very great importance. The companies, however, frankly inform the Committee that if they were compelled to make the tubes wide enough to carry the ordinary rolling stock of the country, the expense of constructing the lines would be so great that they despaired of getting the money to enable them to carry out the enterprise. With this statement before them, the Local Government and Taxation Committee of the Corporation refrained from giving their adhesion to this objection. They submitted the report of the engineers to the Parliamentary Committee, and, while they approved of the recommendations generally, they declined to take the responsibility of insisting upon this.

In April last a joint Committee of Lords and Commons was appointed—"To consider the best method of dealing with the electric and cable railway schemes proposed to be sanctioned within the limits of the Metropolis by Bills introduced, or to be introduced, in the present session, and to report their opinion as to whether underground railways, worked by electricity or cable traction, are calculated to afford sufficient accommodation for the present and probable future traffic; as to whether and which of the schemes propose satisfactory lines of route; as to the terms and conditions under which the subsoil should be appropriated; whether any and, if any, what schemes should not be proceeded with during the present session."

The Remembrancer called attention to the existing state of the law as affecting owners and occupiers who might be injured by any vibration, or a similar damage caused by the construction or working of the railways. At common law, if, either in the course of construction, or owing to the working of an underground railway, property in the line of route is damaged, owing to vibration or otherwise, the owners or occupiers would have a right of action against such railway companies. It seemed reasonable, therefore, to require the insertion in the Bills of a clause or clauses establishing that right. This was most obstinately resisted, the railway companies successfully contending that the introduction of such a clause or clauses would not strengthen the right of any person or persons so injured, while it might give rise to a crop of fictitious claims. In two instances, however, namely, the Baker Street and Waterloo Railway, which would pass under Northumberland Avenue, and the Great Northern and City Railway, clauses were inserted specially protecting the valuable hotels in the one case, and certain property in Finsbury Pavement, which belongs to the City authorities, in the other. The Royal Exchange and the Mansion House are protected in the most stringent manner, for no amount of money can be regarded in the light of compensation for injury to these historic structures. The shopkeepers in Cheapside were naturally anxious that a general clause should be introduced into all these Bills, so that they might have their remedy in the event of any vibration being detected, but as the engineers of the railways assured the committee that, if properly constructed, the railways could not possibly cause any such vibration, it naturally follows that if any damage be sustained it must be in consequence of improper construction, and therefore the companies would be responsible.

The Joint Parliamentary Committee of Lords and Commons were convinced that direct communication through London for the main railway north and south of the Thames, whether for the convenience of their country or their suburban passenger traffic would be of undeniable utility; and they could not doubt that the growing needs of those lines would sooner or later lead to the construction of one or more of such communications. They are required to relieve the overgrown passenger traffic along the chief thoroughfares, to provide for the natural expansion of London, and to check the congestion of our metropolitan population by facilitating cheap communication outwards to a circumference which tends constantly to recede. More of such lines of communication are required with existing suburbs; and there is a growing need of their extension still further into the country, in order to meet the increasing necessity for the removal of portions of the population to a greater distance. That is the popular view, but it must be borne in mind, that if the area of the Metropolis is extended, it will greatly increase the existing inconvenience in such a large city. At the present time it takes from an hour and a-half to two hours to go from one extreme limit of the metropolis to another; if the boundary is further extended the time for communication between one part and another must be proportionately increased, and the consequent inconvenience intensified. Mr. Clarke, when Chairman of the Improvements Committee of the London County Council, dealt with this matter in a report which he presented to the council, and which he subsequently issued in pamphlet form. He contended that, if it were possible, it would be far better to rebuild London gradually. If the large mass of small houses were replaced by larger buildings on the principle adopted in Paris, Berlin, and Vienna, a far greater population could be accommodated within the County of London, and the necessity of going further outside would be obviated. Besides, in his opinion, as a matter of policy, it would be more advantageous to rebuild London with broader streets and large houses than to perpetuate the present system of separating, as far as possible, the poor from the rich. With regard to the question whether underground railways, worked by electricity or cable traction, are calculated to afford sufficient accommodation for the present and future possible traffic, the Committee report that the evidence submitted to them was conclusively in favour of the sufficiency and the special adaptability of electricity as a motive power for the proposed underground tubular railways, whilst the method of cable traction appears to be of recognised utility, especially in the case of steep gradient lines. The proposed routes appear to be fairly satisfactory, considered as an instalment of the more complete accommodation necessary to meet the constantly increasing needs of London. As to the terms and conditions under which the subsoil should be appropriated, the Committee report that in the case of private property, not under the public streets, it appears to them to be desirable that the companies should be allowed to acquire a way-leave, instead of purchasing the freehold of the land, subject to the terms of the Lands Clauses Acts as to compensation. This is a valuable concession to these railway companies. At present, if such a company, or, in fact, any public authority, requires any portion of property for carrying out any work, whether it be the construction of a railway, a canal, or a street improvement, the whole of the property must be taken; but the Joint Committee recommends that these railway companies should be allowed to acquire a way-leave under private property, without requiring them to acquire the whole property; this greatly diminishes the expense of construction.

In the case of public streets, the Committee think it expedient that the companies should be empowered to pass under the streets at at sufficient depth without compensation for the way-leave. In consideration of such free passage, the Committee advise that the companies should be put under obligation to furnish an adequate number of cheap and and convenient trains. It was doubtful in the minds of some people, who had carefully considered the matter, whether railways worked by electricity or cable traction would ever be sufficient for this kind of traffic; but, after taking expert evidence, the Joint Committee are firmly convinced that they will be sufficient.

HOW CYRUS LAID THE CABLE.*

IN *Harper's Weekly* of September 11th, 1858, there appeared the following capital ballad from the pen of John G. Saxe, Green Mountain poet. It is worthy of reproduction at this time :—

Come, listen all unto my song;
It is no silly fable;
'Tis all about the mighty cord
They call the Atlantic cable.

Bold Cyrus Field, he said, said he,
"I have a pretty notion,
That I can run a telegraph
Across the Atlantic Ocean."

Then all the people laughed and said
They'd like to see him do it;
He might get half-seas over, but
He never could go through it.

To carry out his foolish plan
He never would be able;
He might as well go hang himself
With his Atlantic cable.

But Cyrus was a valiant man,
A fellow of decision;
And heeded not their mocking words,
Their laughter and derision.

Twice did his bravest efforts fail,
And yet his mind was stable;
He wa'n't the man to break his heart
Because he broke his cable.

"Once more, my gallant boys!" he cried;
"Three times :—you know the fable"—
"I'll make it thirty," muttered he,
"But I will lay the cable."

Once more they tried—hurrah! hurrah!
What means this great commotion?
The Lord be praised! the cable's laid
Across the Atlantic Ocean!

Loud ring the bells—for, flashing through
Six hundred leagues of water,
Old Mother England's benison
Salutes her eldest daughter.

O'er all the land the tidings speed,
And soon in every nation
They'll hear about the cable with
Profoundest admiration!

Now long live James and long live Vic,
And long live gallant Cyrus;
And may his courage, faith and zeal
With emulation fire us.

And may we honour evermore
The manly, bold and stable,
And tell our sons, to make them brave,
How Cyrus laid the cable.

* New York *Electrical Review*.

NEW PATENTS—1892.

15,469. "Improvements in signalling apparatus for telephones." G. E. HEYL. Dated August 29th. (*Complete.*)

15,477. "Improvements in the means for and method of melting metals and other materials by electricity." A. F. W. KREINSEN. Dated August 29th. (*Complete.*)

15,492. "Improvements relating to the lubrication of parts of machinery with the aid of electricity." H. H. LAKE. (Communicated by J. F. A. Höper and A. Jacobsen, Germany.) Dated August 29th.

15,501. "Improvements in means for lighting oil lamps by electricity." J. DOMECQ-CAZOUX. Dated August 29th. (*Complete.*)

15,552. "Improvements in and relating to electric cigar lighting lamps." W. J. EASTMAN. Dated August 30th. (*Complete.*)

15,591. "Improvements in electric arc lamps." J. C. WUST. Dated August 30th.

15,649. "Apparatus for continuous decomposition of alkaline chlorides by electrolytic fusion." J. STOERK. Dated August 31st.

15,650. "Electric apparatus for illuminating the sights of fire-arms at night." G. G. DI GIOVANNI. Dated August 31st.

15,665. "A method of eliminating the cross magnetism in the armatures of continuous current dynamo-electric generators and motors." J. DICK and W. SCOTT. Dated September 1st.

15,671. "Medicated electricity, or special use and application of electricity for medical purposes." D. BALMFORD. Dated September 1st.

15,689. "Improvements in relays for electric telegraphs." C. R. J. WILLOT. Dated September 1st.

15,690. "Improvements in overhead trolley for electric railways." B. KOCHS and A. KOCHS. Dated September 1st. (*Complete.*)

15,691. "Improvements in electric air ships." C. DRILL. Dated September 1st. (*Complete.*)

15,767. "Improvements in gas outlet valves, or plugs for electric battery cells or other like vessels." W. MOSCNOP. Dated September 2nd.

15,790. "An electric lantern." H. C. GOVER. Dated September 2nd.

15,793. "Method of smelting or overheating iron or other metals by means of electricity." C. G. P. DE LAVAL. Dated September 2nd. (Date applied for under Patents Act, 1883, Sec. 103, March 8th, 1892, being date of application in Sweden.)

15,795. "An improved system of electrical distribution." S. F. WALKER. Dated September 2nd.

15,799. "An improvement in galvanic batteries." E. NUNAN and J. W. NELSON. Dated September 2nd. (*Complete.*)

15,813. "Improvements in the formation of junctions for electric mains." A. M. THOMPSON. Dated September 3rd.

15,833. "Improvements in telegraphic apparatus. W. P. THOMPSON. (Communicated by L. Dill, Germany.) Dated September 3rd. (*Complete.*)

15,840. "Improvements in electric arc lamps." R. E. B. CROMPTON and E. A. N. POCHIN. Dated September 3rd.

15,864. "Improvements in electrical switches." C. W. ATKINSON. Dated September 3rd. (*Complete.*)

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1891.

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1,251. "Improvements in electrical switches." E. ATKINS and W. ATKINS. Dated January 23rd. Has for its object to provide an improved arrangement of spindle spring, whereby less friction exists, and increased certainty of "making" or "breaking" the connection, than in those of present make; also to provide that the connecting cross bar shall be mounted loosely upon a square portion of the said spindle and be loosely connected to the manipulating handle or turn key, so that on "make" or "break" the square of the spindle shall be forward of the square hole in the cross bar, and also of the handle or turn key, that is, that in turning the handle forward, as soon as the spindle reaches a certain point in its travel, the springs drive it home in advance and independently of the said handle. 3 claims.

1,804. "Improvements in and relating to electric motors." G. F. REDFERN. (A communication from abroad by Messieurs Wirth & Co., of Frankfort-on-the-Main.) Dated January 31st. The armature is provided with two coils, one of which is in the circuit of the supply current, and from its far greater number of turns, serves only for the reception of current, and operates only as a driving coil. The second coil of the armature, which is the current-producing coil, has a similar number of turns, is in the same circuit as the coils of the field magnets, and is connected with a special conductor. This coil serves as a special dynamo machine. Inasmuch as it moves with the armature in the magnetic field of the latter, current is generated in it, and this current is led by the special conductor through the coils of the field magnets of the electro-motor. 2 claims.

2,518. "Improvements in electro-depositing." W. GIBBINGS. Dated February 12th. Claim:—The process of electro-deposition of copper or other metals by electrolysis, for the purpose of refining it or them, or for the purpose of recovering the precious metals contained in them, the metal plates or sheets under treatment, with the exception of the first and last in each tank, being totally immersed in the electrolyte, and supported on non-conducting beams, or suspended in such manner, that the total anode surface of each plate or sheet is subject to electrolytic action, the cells being insulated from each other and from the bottom of the tank, substantially as specified.

2,732. "Improvements in flexible supports for electric lamps." W. WHITE. Dated February 14th. A support, according to the invention, consists of two pieces of rigid tube, the ends of which do not meet by several inches, but are connected by arms projecting from each tube, and hinged together so that the two pieces of tube can be moved on the hinge to various angles. The ends of the two pieces of rigid tube are connected by a piece of flexible tube, and the conducting wires are passed along the bores of the tubes thus connected. 1 claim.

3,239. "Improvements in underground conduits for conductors of electricity." J. S. RAWORTH, T. O. CALLENDER, and C. E. WEBBER. Dated February 23rd. Consists in the use of paper tubes embedded in bitumen, either pure or in combination with some other suitable material, as, for examples, sand or sawdust, the whole being contained in and protected by an iron case or channel. 1 claim.

3,269. "An improvement in or connected with mechanical telephones." F. W. DUNLAP. Dated February 23rd. Consists of an acoustic coupling tube adapted to be attached to the mouth-pieces of any two terminal instruments arranged in suitable proximity to one another at the central office or exchange, whereby the vibrations of the diaphragm of the one instrument will be transmitted through the column of air contained in the tube, and so directly communicated to that of the other instrument. 2 claims.

3,383. "Improvements in dynamo electric machines." J. A. KINGDON. Dated February 24th. Consists in winding the armatures of the improved machines with coils of wire quite distinct and insulated from one another, instead of being connected each with the next, as in the Gramme and Siemens armatures. 6 claims.

3,417. "An improved galvanic battery." W. H. MUNNS. (A communication from abroad by G. A. Smith, of Halifax, Canada.) Dated February 25th. Consists of an outer cell, preferably made of porcelain, or the like. Suitable rods project internally from the sides of the cells. Rods are also secured to the bottom of the cell, and have their upper ends secured to the inwardly projecting rods aforesaid. These rods serve as guides for a piece of board having an opening which is passed over the element, and is secured thereto. By this means the element may be raised and adjusted any height out of the fluid. Within the space between the vertical rods or guides is located another internal cell, which contains the fluid and element. The element comprises alternating rows of carbon and zinc rods. Bars of connecting material connect the rods of each row, and insulating plates are placed between the upper ends of said bars. Insulated bolts are passed through the plates and secure the bars together. Suitable L-shaped plates are secured to the opposite sides of the element, and the transverse bolts pass through the vertical members of said plates, thus securing them in place. By means of bolts or screws the other faces of the L-shaped plates are secured to the board which engages the guide rods. 4 claims.

3,553. "Improvements in conduit electric railways." W. P. THOMPSON. (A communication from abroad by E. M. REED, of America.) Dated February 27th. Relates partly to conduit yokes which have depending prominences adjacent to the inner portion of the surface slot of concaved plates, which are secured to said yoke prominences and arranged to form the side walls of the surface slot, and as a means for supporting the concrete filling between the yoke frames along the slot sides within the side arches of the conduit. 12 claims.

3,592. "Improvements in electric alarm apparatus." W. WHITEHEAD. Dated February 27th. The inventor attaches the negative and positive electrodes or poles, each of which are connected to the battery, but may be brought in contact by a rotating lever on the alarm clock, acting as it revolves upon a lever of non-conducting material; this lever of non-conducting material disconnects the poles or electrodes, but on being removed from between them by the movement of the rotating arm on the alarm action, the non-conducting lever is withdrawn, the two poles thus immediately become connected, and set in motion an electric bell actuated by a small motor. 3 claims.

3,893. "Improvements in electrical cables." W. T. GLOVER and G. E. PREECE. Dated March 4th. Claim:—An electrical cable in which the conductors are arranged and distinguished in pairs, substantially as described, and for the purpose of working either single or metallic circuits separately or jointly, substantially as explained.

3,957. "Improvements in instruments for measuring electricity." L. B. MILLER and M. W. WOODS. Dated March 5th. A brass wheel on which the insulated wire is wound has a hollow central tube which contains an axis working on suitable pivots. The reel is fixed to a vertical support forming the back of a circular case with its axis horizontal. The axis carries two small brass arms holding short and light bundles of soft iron wire parallel with it and in a line with one another. On the opposite side of the axis there is an aluminium pointer that balances the iron, and fixed to the axis is a small adjustable weight for bringing the needle to zero. A piece of thin sheet-iron wedge, shaped as seen from above, is bent round inside the central tube and fixed in such a position that the narrow end comes between the inner ends of the two bundles. As the needle moves round, the inner ends of the iron bundles approach the wide

end of the fixed part, and by variation in the width of the narrow end of this fixed part the divisions of the scale may be made of any desired size. 2 claims.

4,120. "An improved imitation candle for use with electric incandescent lamps." W. J. FRYER. Dated March 7th. By this invention the candle can be connected or disconnected by simply lifting it out or pushing it into the socket, which is suitably fitted to receive it. 1 claim.

19,900. "Improvements in or relating to welding or working metals electrically." W. P. THOMPSON. (A communication by C. L. Coffin, of America.) Dated November 17th. Claims :—1. The described method of welding or working metal electrically, consisting in heating the part to be worked by contact with a conductor through which an electric current is passed, and simultaneously springing a voltaic arc between said conductor and another conductor, in proximity to said point of contact, and welding or working the metal when raised to the desired temperature in any desired manner. 2. The general combined arrangement of parts, substantially as described and shown on the drawings.

CORRESPONDENCE.

Incandescent Lamp Tests.

A short time ago I called attention to the recent English and American lamp tests, as showing far inferior results to the older Vienna tests of Continental lamps.

Knowing from day to day what progress has been made in lamp manufacture on the Continent since the latter tests were made, I was in a position to claim the superiority of the Continental lamps over the English and American ones; but I was not in a position to quote any independent figures.

Since then, and by the courtesy of Messrs. Ganz & Co., of Budapest, I have had the opportunity of examining (and through Mr. Déri) of publishing the following life and efficiency tests of at least one make of Continental lamp.

Extract from a "Report of the International Electric Company, Limited, Vienna, to Messrs. Ganz & Co., Budapest :—

"August 27th, 1892.

". . . 15 glowlamps which the factory 'Watt' let us have for trial purposes were tested, and gave the following values :—

Hours.	Average energy in watts.	Average candle-power in normal candles.	Duration of burning in hours.
0	49·75	16	1 lamp 55 hours.
50	49·70	16	1 " 912 "
260	49·70	16	1 " 1,080 "
670	49·60	15	1 " 1,368 "
1,150	49·40	14	1 " 1,660 "
1,730	49·00	12·5	1 " 1,680 "
			1 " 1,850 "
			The remaining 8 lamps still burning.

". . . . (Signed) M. Déri,
"*Director*."

For the sake of comparison I give a table below, wherein I have worked out the average watts per candle-power, and the mean percentage of original candle-power, in order to compare them with the recent Ohio tests of the best American lamps.

Hours.	Average watts per candle-power.		Mean percentage of original candle-power.	
	"Watt" lamps.	Best American lamps (G).	"Watt" lamps.	Best American lamps (G).
			Per cent.	Per cent.
0	3·11	4·20	100	100
50	3·10	4·40	100	97·5
260	3·10	4·95	100	88
670	3·30	5·90	94	71
1,150	3·53	6·75	87·5	61
1,730	3·93	—	78	—

In the above table, the lamps of 3·11 watts per candle-power should have changed their efficiency and candle-power at a far more rapid rate than those having 4·2 watts per candle-power if they had been equally well made.

If the above lamps were considered to be "all out" when they had only dropped 22 per cent. from their original candle-power, then their average life would have been 1,280 hours for an average of 49·5 watts, and for an average of 14·75 candle-power, whereas the American lamps would have been "all out" at 260 hours with an average of 16·1 candle-power and 72·6 watts. On an average 16 C.P. basis at the same watts per candle-power, this would with the "Watt" lamps, be equal to an average life of 1,280 hours, an average candle-power of 16 C.P., and average watts of 53·7 watts.

The above results will answer the following points which several of the chief electrical papers have considered desirable of attainment on the part of lamp manufacturers.

(1.) The production of a lamp which for a life of 1,000 hours shall give an average of 16 C.P. for 56 watts.

(2.) The production of a lamp which shall not vary much in illuminating power during its useful life, and that this object is even worth attaining at the expense of a slightly lower efficiency.

C. J. Robertson,
Technical Director,
Electrische Glühlampen Fabrick "Watt."

Vienna, *September 7th*, 1892.

Mesmerism and Hypnotism.

On page 307 of this week's ELECTRICAL REVIEW, you criticise Mrs. Annie Besant's "Mesmerism and Hypnotism," now appearing in the *English Mechanic*. I am not a Theosophist myself, but I must say that I admire Mrs. Besant's great desire for searching for truth. The lady is very sincere in everything she undertakes, and does not talk or write for the sake of the thing. As a rule, females have not such a good gift for searching into matters mysterious, but I think that if some of our leading scientific men had the same reasoning powers and the same determination that this lady possesses, *we should at least have been able to explain to her what magnetism really is*, and if in doing this we could prove that she was wrong, there would be much more credit attached to the criticism. We do not know what magnetism is, and, until the secret is discovered, I think everybody has a perfect right to have their own ideas on the subject. To criticise Mrs. Besant's ideas on magnetism with *our* present knowledge of the subject, is like the old saying about the "pan and kettle." In my estimation Mrs. Besant is by far the cleverest woman in existence at the present time, and I think that before we make any attempts to criticise the teachings of such an able teacher, we should at least understand the subject in question. Annie Besant's ideas of magnetism are to my mind as reasonable as anyone elses.

What is magnetism? Can the teachers at South Kensington tell us this?

Harry Austin.

September 12th, 1892.

May I have a short space in which to make a comment upon your article of the 9th, *re* Mrs. Besant's speculations on magnetism. The theory of a special variety of human magnetism was broached some years ago by Dr. Richardson. He postulated a form of "thought-ether," standing to the thinking brain as air stands to a sonorous body. And as it is permitted to the various groups of physicists to postulate various ethers to explain their respective sets of facts, why should it be out of order for those to whom the phenomena of thought transference or telepathy are experimentally demonstrated facts to postulate a thought-ether, and attempt to work out its hypothetical properties? This, it seems to me, is what Mesmer and Paracelsus did, only they may possibly have confused their thought-ether, or "astral light," with the other physical ethers of which we hear so much. As to theories of human magnetism, they are perhaps a little premature; but it is not very absurd to suppose that the human body may one day be found to possess magnetic, as it is now known to possess electric properties.

Herbert Coryn.

September 13th, 1892